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Making A Martian Home: Finding Humans On Mars Through Utopian Architecture

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MAKING A MARTIAN HOME: FINDING HUMANS ON MARS THROUGH UTOPIAN ARCHITECTURE

ABSTRACT A renewed public and state interest in space exploration in recent years, coupled with technological advancements in rocket science and architectural systems, has made design and engineering initiatives for Martian living tangible and urgent. This article traces the practice of utopian architectural design of a home on Mars. This home has been described by its architects as a 'place for people' and for 'all of humanity'. Off-Earth habitats have traditionally been designed with emphasis on the functionality of surviving extreme environments. New designs for Mars aim to make human-centric homes in which people can be comfortable.

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However, when confronted with the known realities of the Martian landscape, such designs reconfigure the place and form of the human. The Martian landscape requires that a home shelters the human body from hostile elements through totalising closed loop architectural systems. In such extreme architecture, the human form is configured as a calculable body, and becomes 'erased'. This article ethnographically traces how the human is imagined in such design practice and asks what happens to the idea of the human through informed design thinking as architects meet space scientists. It traces how utopic motivations to build a space 'for all humanity' are challenged through the material and practical reality of making design choices and exclusions. The ethnography follows the figure of the human as it is imagined as an emergent Martian lifeform which confronts the problems of the different gravity, light, radiation, and terrain that a life on mars would entail. Considering how the concept of 'living' might be possible in a future Martian habitat involves the practice of imagining radically alternative forms of life. By tracing how these are imagined, contested, and considered this article asks how practices of conceptualising radical alterity relate to understanding oneself as connected to the enduring idea of being human.

KEYWORDS: mars, habitat, anthropology, architecture, design, outer space, Utopia

INTRODUCTION

> A map of the world that does not include Utopia is not worth even glancing at, for it leaves out the one country at which Humanity is always landing. And when Humanity lands there, it looks out, and, seeing a better country, sets sail. Progress is the realisation of Utopias
>
> Oscar Wilde, The Soul of Man Under Socialism, 1891

A renewed public and state interest in space exploration in recent years, coupled with technological advancements in rocket science and architectural systems, has made design and engineering initiatives for Martian living tangible and urgent. This article traces the practice of utopian architectural design of a home on Mars. This home has been described by its architects as a 'place for people' and for 'all of humanity'. This article presents research as part of a large 5 year collaborative research project titled Ethno-ISS, exploring diverse anthropological contexts of the International Space Station (ISS). Off-Earth habitats such as the (ISS), and its predecessors such as MIR and Skylab, have traditionally been designed with emphasis on the functionality of surviving extreme environments. New designs for a human habitat on Mars are, as stated by their architects, human-centric homes in which people can be comfortable. The London based architectural firm with whom we conducted our ethnography is an international leader in cutting-edge design, whose portfolio includes international airports, museums, and stadiums. These architects have also worked directly with major space agencies, including NASA and the European Space Agency. When presenting their design ideas for a Mars base, the lead architect would frequently start with an image of the inside of the ISS and talk about how, whilst functional, it was not a space in which humans could make a long-term home with its stark functionality, plethora of wires, pragmatic handles, storage compartments, instruments etc giving an aesthetically cluttered look. In the face of this our interlocutors presented a new age of the space base, one to be lived in, in which humans could dwell.

However, such utopian designs reconfigure the place and form of the human. The Martian landscape requires that a home shelters the human body from the known realities of its hostile elements. A Mars base must be a totalising closed loop architectural system. In such extreme architecture, the human form is configured as a calculable body, and becomes 'erased'. The body becomes, as anthropologist Emily Yates-Doerr has so well-articulated, a 'learned object of medicine' (2017; 143) or in our case a learned object of architecture. In this regard, there is a tension between the human body imagined and configured by utopian architecture, and the body objectified as a series of medicalised measurements and limitations that must be addressed due to the harsh reality of off-world living. This article ethnographically traces how the human, both biologically and socially, is imagined in such design practice and asks what happens to the idea of the human through informed design thinking as the architects meet a collected advisory panel of space scientists. We argue that architectural utopias, in focusing on technologically driven progress, ignore a biosocial complexity of Mars living, and it ignores the sort of bio or medical materiality that biosocial realities require. We highlight the design of the Mars habitats to suggest that utopic vision is often a

very useful way to ignore the materiality of the now, which causes such design ideals to fail in complex, though sometimes productive ways. We conclude the article by suggesting that utopic motivations to build a space 'for all humanity' is challenged through the material reality of making design choices and the exclusions that these choices involve. Such utopian designs are always likely to fail as they meet a material reality however this is necessary to their function in that they outline the forms of problems to be overcome to enable particular forms of future, with particular forms of human life, to become possible. This article asks what emergent forms of 'life' and 'living' might be possible in a future Martian habitat, and how we can remain open to the radical forms of alterity that such futures may show us.

A MARS HOME AS A FIELD SITE

In a meeting space in East London's digital district, Shoreditch, around 30 experts gathered on a cold November morning to deliver feedback to a world leading architecture firm on their designs for a Martian habitat. The firm had made it to the final stages of a NASA competition and were required to present detailed designs of habitats that could withstand the environmental conditions of Mars, and be a suitable long-term home for future space travellers. The experts included structural engineers with specialisms in Astronautics and space physics; Martian weather experts; material designers; experts in space plasma and radiation; glass engineers; textile designers; experts in mining, art and architectural anthropology.

The types of discussions and competitions our interlocutors find themselves in mark a slightly more serious turn for Mars living. The hype of Mars One, the private Dutch organisation and now bankrupt company (2012-2019) that gained large amounts of money from investors with the promise of sending humans to Mars to establish a colony, gave rise to much lateral thinking, and gave some promise to private enterprise, with a subtle message of being 'for the people'. The Mars One mission, which was to be launched through Falcon 9, made a large public call for explorers. While the call was, in some regards, empty, it was to be the first mission to colonise the Red Planet, and the list for volunteers had 400,000 applicants. It was long critiqued by the scientific establishment as nonsense. As Anu Ojha OBE, director of the UK National Space Academy remarked, "Obviously this is something that has captured the public's imagination, and Mars One obviously has a great PR team, but space engineering obeys the laws of physics not PR" (Seedhouse, 2016: 10). However, it did get architects and other people in the public sphere thinking. Mars One did not originally have plans to return its humans to Earth, and was described as a suicide mission by NASA and other space experts (Brennen 2013). While the current Mars habitats are now planning for 6-9 month stints (rather than 20 years), they are informed by the same spirit of a "space for

humanity". Currently, Elon Musk's private 'SpaceX' firm is envisioning this goal, and it has the financial backing and technological precedence to see it through, where Mars One did not. SpaceX is currently hyping its new designs for its "Starship" launch vehicle, able to carry 100 Metric tons on a 6 month trip to Mars, though the public details of how humans will live on Mars once they arrive are few. Like other space missions before it, SpaceX's Mars mission markets itself as a project for humanity. The public slogan for Space X's Mars mission reads "Mars & beyond: The Road to making humanity multiplanitary" (Space, 2021), though embedded within its goals is also an eschatological rhetoric, a planning for the future of humanity after the destruction of the world. As Elon Musk has stated, "There is "some probability" that there will be another Dark Ages, particularly if there is a third world war… We want to make sure that there's enough of a seed of human civilization somewhere else to bring civilization back, and perhaps shorten the length of the Dark Ages" (Solon, 2016). Here, 'for the people' is about the preservation of 'all humanity', a sentiment famously shared by British astrophysicist Stephen Hawking, who likened space exploration as a form of 'life insurance' (Shiga 2008).

Still, "for the people" means something else for the architects in Shoreditch. The first visitors to the red planet are still likely to be specially trained, highly scrutinised scientific elite. The design they presented, whilst being "for the people" was less about making a habitat 'for the public', but rather making a habitat that was more than utilitarian, but was pleasant and enjoyable to live in, it was to be a dwelling for 'the human'. The architects wanted the space to be attentive to basic human needs of dwelling and incorporated spaces of contemplation at large windows. Here the design renders showed images of future Martian dwellers reclining in 3d printed chairs, set amongst house plants and wood effect floors, looking out over an expansive Martian landscape.

As anthropologists, we had been working with these particular architects for over a year. We had visited their main office in London to look over their Mars habitat designs. We were invited to look at the materials and methods they were employing in their designs and we were able to observe experiments with 3d printers; the utilisation of osteometry in structural design; experiments in inflatable architecture and other exciting innovations in experimental design. They had been generous with their time and seemed genuinely interested in our anthropological motivations despite the fact that when we were asked about the designs, we seemed to keep coming back to the topic of how people around the world manage human excrement. This topic was useful to think through the everyday practicalities of living in a closed architectural system, that is, in a building where everything is internally controlled and regulated, and where there is no liveable outside space. The body becomes a heightened nexus of control and

the management of waste in both a practical sense and social sense is an important consideration.

In Anthropology, the scatological has been considered in order to think through the divisions of the sacred and the profane (see Moore and Moore 1986), or to think through the history of the city and its relation to the body (see Sennett 1996; Pile 1996; Jeevendrampillai 2019) or as a marker of class distinction, modernity and urban belonging (Appadurai 2001) but here the conversation around how people manage bodily waste was useful to think through the issues of the division of architectural space. One of the assembled experts, Simon, who had spent significant time on a Antarctic research base told the architects a story of how, whilst the base was practical and safe against the extreme colds of Antarctica, some of the architecture, such as the ventilation systems caused issues for the inhabitants. The bathrooms, he said, shared ventilation pipes, and so if someone caused a smell in bathroom one, this would carry through to bathroom two, three and so on along the line of bathrooms in each person's room. Eventually the crew decided that the bathroom of the last room should be the one to be used if anyone needed to make a smell.

In thinking about building a home, one needs to think through the amount of personal space one might need or about how people think about polluting or abject smells. Such things are deeply cultural and vary around the world and throughout history (c.f. Laporte 2002). In this way, the designs of homes have often been architectural and material reflections of the ways in which we relate to our bodies, others, and the world around us with regard to notions of cleanliness and dirt (c.f. Douglas 2003). As anthropologists such as Pauline Garvey (2001), Susan Kent (1993) or Christine Helliwell (1992) have shown, the ways in which furniture is arranged, the number of partitions in a home or the ways in which the light, smells and other sensuous aspects of the home are experienced are different dependent on the cultural context of that home. So when you ask an anthropologist how much personal space people need, as the architects did in this meeting, the answer, almost inevitably is, "which people"?

But the designs of the Mars base have been accompanied with the narrative that such a base is for the future of all humanity. The promotional video of the mars design talked of 'producing designs for the next great step in human endeavour', of 'our future,' and the steps 'we' will take. We emphasize the term 'we' here to draw attention to the universalisms being foregrounded by the rhetoric of the design presentations. The diversity of some of the design interests in the room betray in some regard the type of individual framed as a 'universal'. For example, clothing designers marketed "clothes for the future", configured for hyper-masculine bodies, with militaristic imagery depicting post-human sentiments and dominance over nature. Other designers displayed experimental design practice that pressed for a new utopian

future of human communication and social interaction. Postcolonial scholar Sylvia Wynter argues that the European encounters of other 'worlds', particularly the encounters of lands by Christopher Columbous in 1492, was vital to the formulation of European representations of the human (Wynter 2003). Such representations take the European figure, epitomised by Leonardo de Vinci's 'Vitruvian man', which he drew with a precise description of proportions, as the archetypal human form. Wynter argues that conceptualisations of the human have been dominated by European thought and that such archetypal images work to exclude other ways of being. As Katherine McKittrick (2015) outlines of Wynter's work, this image of the human as a European figure can become the 'referent-we of Man' that all other forms of life and human figures must struggle to define themselves against. Wynter's work - which was deeply influenced by the work of Franz Fanon (1970) in particular his ideas of sociogeny - argues that major embodied experiences of being human, such as race, are not a simple biological given but come about through a history of stories and symbolic meanings (Wynter 2001).

David Valentine (2017) notes that critical scholars of space, which include Hannah Arendt (1968), Paul Virilio (1997) Peter Redfield (2000), have suggested that the future imaginaries of off-earth living offer a spatial-fix, a story, and symbolic grounding for issues of difference. In this view, outer space offers a physical context that presents an idea of 'humanity' that is unbounded from the traditionally restrictive categories of human difference. These universalisms of 'we', 'for all humanity', and 'our future' which underlies the rhetoric of space imaginaries belie the politics of difference upon which the very idea of the human is built. Narratives of space futures retain the white, able-bodied cis-male heteronormative man at the centre of the story. Issues of inclusion and diversity persist throughout designand STEM fields at large, and they are ones of which the architects are well-aware. While they continue to be challenged by exclusivity in design practice, they are also actively working to improve inclusivity in their field.

Humanness in the context of this design is framed as an utterable whole -'humankind' - through an appeal to a common nature, 'our future' by which all difference is commensurable. But as critical scholarship on racial politics has shown, "any attempt to fix or problematise the "human" by way of a solution to any general problem of the nature of difference is still barren unless it acknowledges the historical centrality of Black death and attempts at Indigenous extinction to the constitution of the problem of general humanness and of difference itself" (Valentine 2017: 188). New problems of difference always defer the universal project, and as Valentine suggests, a new politics of difference will emerge through the radically different material conditions of off-earth living as it offers new perspectives and relative positions from which the idea of the human is understood. In this article we

focus on how the specifics of living on Mars necessitate a consideration of the form of life possible on other worlds and, as such, how the promised spatial fix and associated universal futures become less utopian and more 'real'. This affront of the real to the utopian design ideal of making a home for the future of humanity, is one based in the material biosocial reality of the now. That is, as the architects deal with the practical issues of building a home in an inhospitable terrain they are forced to make choices about the nature and form of human life and living. These choices are more than technical, underpinning them is a notion of what it is to be human. Pitrou (2015) through his work among the Mixe Amerindian people of Oaxaca Mexico, builds upon the works of Hocart, Bloch and Agamben, to provide a framework for rethinking how 'life and living' are made by setting out the "principle that the diversity of actions performed during rites of life is explained, first, by the fact that humans do not always objectivize the same vital processes and, second, by the fact that the conceptions they have of these processes are not the same everywhere." (2014; 101). Such is the case of the team creating a space for 'human life' on Mars. We argue that in designing a utopic space aimed to represent the future of living off-world, the design team and engineers play into this incommensurability of objectifications. That is to say, there is a difference between the forms of life conceived by utopic architectural designers, and, say, a radiation specialist. As Pitrou notes, "Without denying that humans globally perceive the specificity of certain vital phenomena within an environment, their representations are far from uniform. Instead of looking for a (near) universality within ritual dynamics or treating life as a natural given, it is more fruitful to try to take stock of the multiplicity of configurations of agency imagined to explain the causes of vital processes as well as the ways in which humans try to control them." (ibid). Indeed, as the ethnography below demonstrates, there are a wide range of concerns of what constitutes 'living' on Mars, all considered crucial by their advocates, but which diverge into different trajectories of forms of life as they are brought to their logical conclusions.

UTOPIAN SPACE HOMES

In defining Utopia "at the horizon", the famous Uruguayan writer Eduardo Galeano outlined both the seductive and productive nature of Utopia as the driving force which can "cause us to advance" (Galeano and Borges 1995). Since Thomas More first presented his eponymous island to readers in 1516, the idea of utopia (from the Greek – Ideal, but not realised, place), has been a central concept and problem within intellectual and disciplinary philosophy and practice. As Miles (2017: 1) has outlined, 'the desire to create a better world is central to Western Modernism' and, as such, the concept and operative social mechanics of Utopia have received significant anthropological attention

(see Maskens and Blanes 2018). Utopias can be idealised places from the past or projected into the future, yet they are always 'incomplete, an always unfinished project' (Miles 2017: 1). A focus on Utopia asks one to understand a place that is both everywhere and nowhere (Shukaitis 2004). Maskens and Blanes articulate utopia as grounded in ideal worldviews and therefore form a value that becomes 'a concept for ordering and structuring meaning in the world' (2018, xv). That is, it directs social actions because the ambition of realising a utopia requires the "transformation of value as a practicality that emerges from the poïesis of social life." (2018, xvi). They argue that "there is a thin line between utopia as an act of imagination and its actual concretization" (Ibid, xiv). While this may be true, what we outline in this paper are the material conditions and transformations that define the structure and stability of this 'thin line'. As discussed below, the thickness of the regolith structure for the Mars habitat becomes, for us, an analogy for the boundary between imagination and the practicality for the material conditions of Martian life. The architects and designers with whom we work recognise what they see as failures of the present state of the art of space design, and thus their renderings fit the utopian models of what Ernst Bloch defined broadly as "reaching beyond the present" (1988), encompassing constructs of both hope and nostalgia. However, as we chart below, these attempts are premised on an imagination that prefigures a relationship between the human body and the built environment. Utopian ideals are, then, made complex by the material challenges of the home and Mars that reconfigure the human body.

Utopian ideals have long been materialised through the architecture of the home (see, for example, Modena 2011). Such ideals aim to prefigure the sorts of humans we can be. As Coleman notes "architecture and utopias both refer to bodies by seeking to establish harmony across and through discontinuous parts" (2007, 16). Pierre Bourdieu (1970) brought attention to how the architecture of the home reflects the social structures of the society in which it is built, through keeping light/dark, hot/cold, male/female separate in the Kabyle house, thereby reflecting orders and divisions in wider society. Buchli (1998) goes further to show how, in Soviet Russia, architecture not only reflected the social, but was used to radically alter social norms. In his analysis of the Narkomfin communal house, Buchli outlines how the building asserted the ideals of communal living through shared heating, storage, a library, shared cooking spaces and so on. For example, Buchli demonstrates how changes in where a dining table is placed in the home, from the centre of the room, to the edge of the room, reflect the shifting position of the family unit as the ideal type as society placed less emphasis on family bonds and more on wider social bonds. The minute details of architecture matter in that they both reflect and constitute social relations. As such the design of architecture is also the design of a particular way of living.

In terms of thinking of utopian design of human habitats in space, Fred Scharmen notes how space has not always been for everyone. In his book 'Space Settlements' (2019) Scharmen takes a detailed look at the history of imagery that pervades the popular culture of space settlements. He locates the 1975 NASA 'Summer Study' workshop that brought together architects, urban planners and designers to think through space settlements as a key point in the development of the modern imaginary of space settlements. The artist and architect Rick Guidice and planetary scientist and illustrator Donald E. Davies created renderings for the project (See Figures 1 and 2). These images have, in many ways, become the blueprint for the image of space settlements in the popular space imaginary. Its influence can be seen in the 'Cooper base' of the 2014 Hollywood blockbuster film Interstellar, as well as on the cover of books by famous Sci Fi author Arthur C Clarke, and in Star Trek films. Elements of the torus have, according to Scharmen, influenced the design of the new Apple Inc Headquarters in California. The Stanford torus was a proposed space habitat for 10,000 to 40,000 people. It was a donut-like ring shape that rotated around a central axis. The interior was so large as to create a living environment similar to the one on Earth. In fact, but for the domed roof and curved 'ground', the torus looks very similar to many affluent American suburbs. In particular, the torus resembles Frank Llyod Wright's 1932 'Broadache City' designs of a suburban utopia. Scharmen remarks on the ways in which the visions of space settlements emanating from the influential 1975 workshop resembled a form of living equitable to that of the wealthy, modern and productive citizens of modern USA.

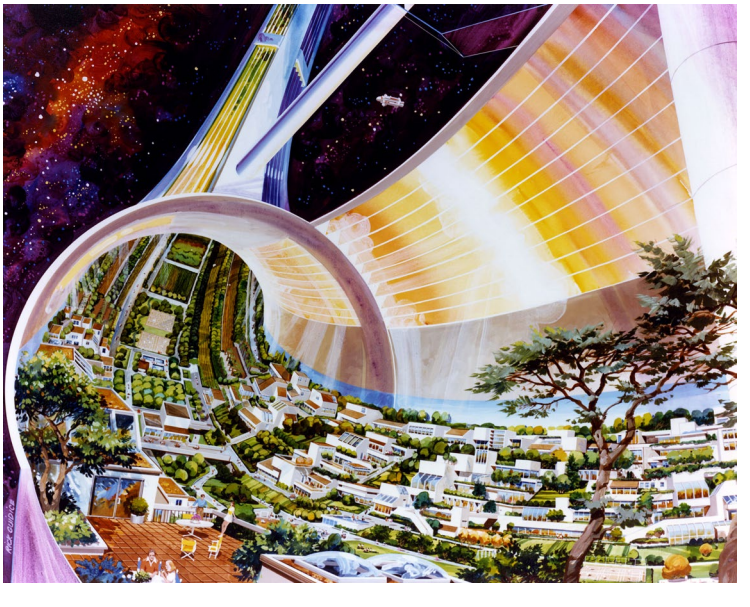

Figure 1. Stanford Torus cutaway view, by Rick Guidice, courtesy of NASA, 1975.

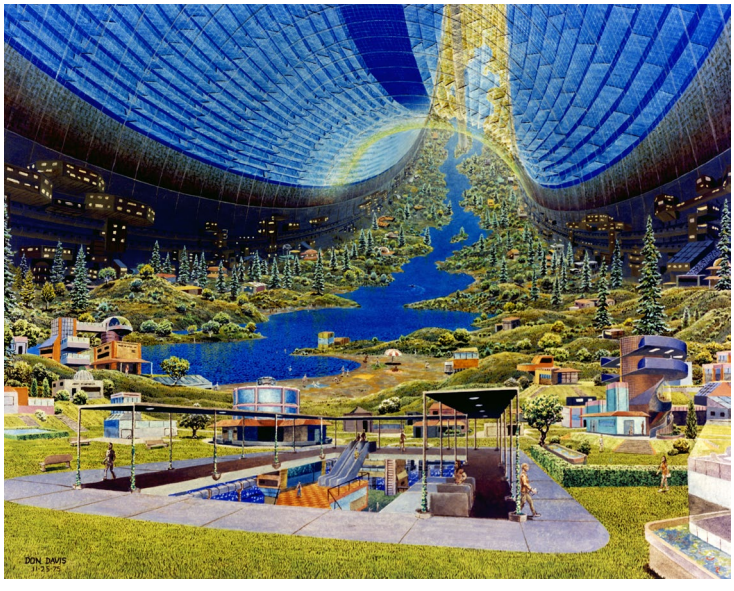

Figure 2. Stanford Torus interior, by Don Davis, courtesy of NASA. 1975.

Scharmen draws on the work of post-colonial theorists, notably Dipesh Chakrabarty (2016) to work through the links between colonialism and utopian space habitats. Noting how the term "space colonies" was discouraged due to its associations with control of territory and the politics of extraction, he writes that colonialism "is explicitly connected with the production of certain kinds of subjects, the recreation of certain others, and, when necessary, the suppression and elimination of still more." (Scharmen 2017; 192). But, here he notes that this goes beyond recognition of different cultural perspectives on the home or dwelling. Mirroring Chakrabarty he notes that every time we make a world, we also make a new subject within it. The conception of the space habitats then is a conception of a particular type of human life and way of living. Writing of the torus images he states "Effectively, the space natives are Californians" (192). Utopian design pushes the ideals of the present into a future yet to come and prefigures them as a credible prototype to work towards. This vision is always from somewhere and carries with it a weighty baggage of notions of the ideal human at one with their ideal dwelling.

In this sense the study of utopian visions and the role in producing narratives of the future can be telling as Jameson writes in 'Archeologies of the Future' (2005), "utopia can serve the negative purpose of making us more aware of our mental and ideological imprisonment … and that therefore the best Utopias are those that fail the most comprehensively." (2005: xiii). In our case the utopian visions of the architects were challenged by the knowledge the assembled experts could provide in terms of the lived experience of the Martian

home. In particular, this came down to effects of things such as radiation and gravity on the body. The body had almost entirely been ignored in the discussions and presentations of the renders. The people in the images, where to an extent assumed to be, as Scharmen might say 'good Californians', professional, young scientists doing Mars things. The body was assumed to be fully accommodated by the technology of the Martian home which was itself a life support machine.

Utopian ideals of living in space have always been about transcending the limitations of the body through technology. As Asif A. Siddiqi notes in his discussions of early Russian cosmists, spaceflight was about liberation from the Earth. Around the 1920s, the excitement around the new potentials of aviation could not match the speculations around spaceflight. Spaceflight offered a "universal (in both senses of the word) appeal that aviation lacked" (2008: 264) as it could offer liberation from the signifiers of the past such as "social injustice, imperfection, gravity and ultimately the Earth" (ibid). For the cosmists, this liberation was tied to the limitations of the mortal body. Russian cosmism was a philosophical and cultural movement that emerged in Russia around the turn of the 19th and 20th centuries. Combining natural sciences, Orthodox religious practices and philosophy, the cosmists were interested in how technology could lead to new stages of human evolution and transformation. In particular leading figures in this movement such as Nikolai Fyoderov were interested in immortality and believed that a focus on the development of space technology could help all mankind overcome issues of death. In particular, Fyoderov brought together emerging science on the structure of the atom and Darwinian evolution to argue that all the atoms of the dead could be reconstituted in the cosmos as humans become a space dwelling species. The biocosmists had a huge influence on the early days of space flight in Russia and around the world. As such, Fyoderov has been described as the true father of the Soviet space program, and he had direct influence on the work of rocket scientist Konstantin Tsiolkovsky who was hugely influential in the Soviet space program (Young 2012). Whilst his position might seem abstract from narratives of space science today there are some core similarities, namely the ways in which technology allows new phases of human dwelling in previously unliveable environments and as such, allow a vision of humanity to expand into the future.

The home, as conceived in the architectural visions of the Mars base by our interlocutors, is, by necessity, a hybrid, life-sustaining form of technology. As a closed loop system, the relationship between the human body and the building it occupies is holistic. There is no 'outside', no opening a window or going for a walk (without a suit). The threat that the Martian environment poses for human biology is severe. The planet has no breathable atmosphere, and it is bombarded by radiation and intense dust storms. It is defined by alternative gravitational conditions (about a third of Earth's gravity), confined

spaces and relative isolation of living. Further to the biological, the phenomenological experience of the human body in space, or on Mars would be a very different sort of experience of the body one may have on Earth. Such contexts of off-world living have inspired social scientists to theorise the ways in which the human form becomes delimited and cyborgian - originally conceived as a necessity due to the draconian requirements of off-world living (Clynes and Kline 1960). The concept of the cyborg was later adapted as a conscious societal rejection of binaries and boundaries between body, machines, environment and architecture. (Haraway 1994). Clynes and Kline (1960) definition of the cyborg, in which the human corpus is merged with cybernetic parts to modify autonomous self-regulatory control functions, is helpful to conceptualise the radical physical human/habitat hybrids, and the eco-bio-processes that operate within these systems. However, it is this later radical feminist construct that holds analytical weight in a discussion of how engineers and architects make design choices that either reproduce constructs and structures of human life and living on Earth, or make the conscious decision to reject normative binaries and boundaries or what Haraway has described as the "seductions to organic wholeness through a final appropriation of all the powers of the parts into a higher unity" (Haraway 1994; 84). Reproducing the forms of life on Earth is almost unavoidable, but it also lends itself to forms of failure when the material and ecobiological context of the body on Mars begs for re-evaluation. Becoming 'cyborgian' is difficult as it requires anticipating the diverse forms that difference takes in an other-than-human world, and it risks promoting the slippery tropes of post-humanism and transcendence that are so contrary to the project of designing 'for the human' (Parkhurst 2012). Designing a space, then, for the 'human' when the forms of life and living that constitute the 'human' are under reconstitution is, in short, deeply challenging.

For a habitat in space to be home in the same way it would be on earth then one would need to experience one's body, and its relation to its material environment, in a similar way. But in space, on Mars or the Moon, one does not experience one's relation to the material environment in the same way. Furthermore, underlying this point is an assumed 'our' of body, 'our' of experience, which erases in its construction the differential racial, gender and ableist politics of experiencing an embodied subjectivity. The Martian home starts to crumble as the contingency of the human body is highlighted and, as we attempt to deal with issues through cyborgic interventions the notions of the human body also start to earn new coordinates.

In her book 'Into the Extreme' (2018), Valeree Olson considers the ways in which the body is configured, measured and understood within space science. She extends Foucault's notions of biopolitics to coin the term eco biopolitics. By this she wishes to consider the body as governed within its relational dynamics to its environment.

In the case of off-earth habitats this means considering the body in alternative gravities (c.f Parkhurst and Jeevendrampillai 2020). She notes how NASA redefined the normative conditions of the body, which feels many physiological effects of being in space, such as sickness, dizziness, muscle atrophy, to the so-called 'space normal'. Here the normal and the pathological are redefined in the context of the off-earth environment. If humans are to move from space exploration to space settlement, as Obama's (2009) Augustine commission suggests we do, then the types of normal states of bodily experience extend beyond a temporary or extreme experience and become a permanent condition in which to dwell. On Mars these bodily experiences have to be dealt with in terms of the long term lived experience of how we 'dwell' as humans.

In 2005, NASA launched the Centennial Challenges Program in order to engage the public in the process of advancing technological development. The design that we tracked used 3d printing robotic swarms to print Martian regolith over an inflatable pod. In the video and image renders produced for public engagement and PR, the base sits as a curvy bulge amidst the blood red Martian soil. It seems at one with the landscape, imagined at dusk as the lights from the base illuminate an otherwise uninhabited stretch of red Martian soil. A prototype of the domestic interior was produced, encased within an inflatable pod, for a show at London's design museum some time after the advisory panel meeting. Here, exhibition goers were invited to recline in 3d printed chairs, or to sit at a 3d printed table and look out of the 'window' onto the Martian landscape which was simulated by a large tv wall. The architects state that their 'radical design' "places the human experience at its core" where "work, life and living combine holistically" to ensure people "feel connected to each other, to themselves and to their home". One of the main motivations was the abject 'failure' of the International Space Station (ISS). Multiple images of the inside of the ISS are shown whenever the architects present themselves in different venues and contexts: A miserable space, which, as the architects articulate, must create miserable people.

On the day of the advisory panel meeting the designs of the Mars home were presented to the room of experts and multiple images were placed on the walls of the meeting room in which we worked. The 'experts' took it in turns to introduce themselves and their expertise in relation to the project. We then took time to work through the design renderings thinking through the themes of 'protection', 'construction' 'habitation' and 'general comments'. The themes were preselected by the designers and opened up for comments by the group.

"GREAT - BUT YOU'RE ALL GOING TO DIE"

After the presentation by the architects there was a small silence from the experts opposite until Beth, a world expert of space plasma and

radiation broke the respectful silence. “I mean, these [images] all look great but you are all going to die”. She then proceeded to outline how Mars was significantly more radioactive than Earth due to a thin protective atmosphere and long duration exposure of the rock surface which has significantly less tectonic activity. A discussion then ensued as to how best protect people from this radiation.

“The shell structure is not thick enough” said Beth, “it will need to be at least double that” and so the architects, who had already considered the problems of the regolith width, but were worried about structural integrity, asked about making it a meter thicker in order to address the radiation issues. She said “that’s much much better. But you are still all going to die.” so they move to two meters and then three meters. “Better, you won’t die as fast” she adds, “Actually better to have it at one meter and die quicker. Two meters you live longer, but will suffer longer. Really, it’d be best if you just go way underground…”. John, an expert in Martian weather, interjected “Well, you’ll also need a meteorite filter … and the wind, the wind will erode that structure, and the storms, the storms last for days, your robots won’t work” he goes on explaining the nature and power of huge Martian dust storms. He explains how sharp dust, formed from wind erosion and not softened by water, can circulate for days with incredible erosive force for any potential home.

Beth then tries to helpfully suggest some solutions. “If you move the habitat into a valley then you might be able to mitigate some of the cosmic radiation”. There was a brief conversation about using a nuclear bomb to blast an inhabitable space into the side of a rock face. Some people in the room were shocked by the suggested use of nuclear technology. The disagreement about the use of nuclear bombs, or nuclear power for energy created a little tension around ethical positions. The debate around nature, atmosphere, pollution all have different coordinates on Mars as ethics are radically recontextualised. As one of the group joked, “anyone who is worried about radiation wouldn’t be going to Mars anyway”.

Soon the experts had talked themselves into moving the base from the open landscapes of the Mars plains, as seen in the renders, through a valley, embedded it in a mountain side and eventually placed it within a Lava tube (of which there are many on Mars from previous geological activity). The group discussed the suggestions and worked through the practicalities of the hypothesis. Lava tubes made much more sense to the experts. They are already hollowed out, they are deep underground, they protect against both radiation and the incredible dust storms and plumes, and are naturally temperature controlled. At this point the utopian ideal imagery that placed the humans at home in the middle of an expansive Martian landscape in renderings that resembled Mars versions of 17th century landscape paintings, had been totally erased and replaced with something more pragmatic. Steve, a mining expert, suggested that the Lava tubes would bypass

the 3D printed shell altogether and protect from meteorites. Humans, then, would not only be Martian but subterranean. Such structures are far more suitable for the human body - in addition to being temperature controlled and radiation proof, they may help trap and preserve moisture, and potentially provide much larger liveable space than modules built on the surface. However, they cause a type of cognitive dissonance for the designers inspired by the forms of living depicted by such projects like the Stanford Torus discussed earlier in this article. As wired magazine described similar experimental earlier designs by design firm ZA architects, humans would become 'mole people' (Shubber, 2013), invoking the type of moral sacrilege of underground Morlockian life portrayed by H. G. Wells in the dystopian future portrayed in *The Time Machine,* whereby the post-human race of Marlocks are marked by barbarism, operate ancient machines, and participate in cannibalism to stay alive. The landscape ideal was starting to fade.

There was a vast disconnect of the utopian visions between the architects and the scientists and engineers, all of whom had different ideas of the meaning of ecology and building a home. As we moved onto the theme of construction, the dynamic between the robots and people on Mars took centre stage. People discussed the robots' lifespans, their independence and their "ecology". "They need to do more, we need to rethink the ecology of the robot swarm" said one scientist. The architects were encouraged to embed AI technology and for the robots to take on the role of the workers. Anthropologists such as Eton Wilf (2013) and Jenna Burrell (2016) have asked questions as to the role of agency, ethics and responsibility when it comes to algorithms that are programmed to write other algorithms. How can we account, they ask, for design intentionality, the ethics of the outputs and the forms of life that are designed for under such circumstances? More than evoking the deadening efficiency of Arthur C Clarke's Hal computer, questions as to the biological and technological limits of agency are raised anew here.

When it came to habitability, the final section, the participants in the room were tired. The lead architect was visibly weary after hours of having his design unpacked. However, we moved to the crux of the matter. Further to the technical problems of extreme environment closed loop architectural systems, discussion turned to what sort of home people would actually want.

People talked about a desire to see life, to grow plants. Others noted that the human eye would have to adapt to seeing more red. There was also a discussion of how to build steps, how firm to make a mattress in gravitational conditions of about one third of the Earth's gravity pull, or how tall the ceiling should be in a place with one third the Earth's gravity. Humans would walk, talk, breath, move and feel differently, impacting upon the mind, emotion, and complex systems of social relations (Parkhurst and Jeevendrampillai 2020). The people that lived there would be taller, their bones and muscles would feel

different, and, crucially, they would have a strong interdependence with technology to the extent where the boundaries of human and technology may be dramatically redrawn, invoking again the image of the cyborg, and asking questions on the nonhuman agents who facilitate new forms of living.

Speculative matters on the future of the human sat alongside conversation as to the practicalities of close living. Whilst the day had started out with grand visions of Mars bases across a pale crimson landscape, the experts had now placed the base in a lava tube and once again returned to Simon's anecdote about bathroom smells on the British Antarctic Base. People noted that smells on Mars would linger longer in the air, and that astronauts on the space stations have said foreign and bodily smells can be the source of arguments.

If the Martian habitat is to replicate the values of living on Earth, participants asked if one prays, where is Mecca on Mars? Heinlan had anticipated this of course in the opening of 'Stranger in a Strange Land' (1961), in which the Muslim Anthropologist returns from Mars with the Martian born human man. Islamic councils around the globe have debated such issues for the reality of Muslims living on the International Space Station, a human dwelling that witnesses 16 sunrises and sunsets a 'day' (see, for example, the 2007 document issued from Malaysia's National Fatwa Council). On Mars, it would remain a genuine concern. Following a conversation about using LED screens as windows, participants asked as to what would be projected. Would the screen simply display the view of the Martian landscape that was lost as the Martian home was moved underground? Would it take the opportunity to instead show landscapes or ecology from Earth, or other images of the dwellers' former homes?

CONCLUSION: A HABITAT FOR HUMANS?

What is at stake in these conversations is the question of what is lost in the gap between the utopian idealisations of the architect's designs and the biological and technological reality of attempting to actually realise those visions when confronted with biosocial and pragmatic complexity of living in a new and harsh environment. As Oscar Wilde, quoted at the beginning of this article, had mused, "progress is the realisation of Utopias", but as one reaches over the horizon of a utopia, one is faced with the practical realities of making that ideal a reality and as such one's eyes move to the horizon once again. In this sense, the visions of the architects were always bound to fail. However, this failure is conceived of as a necessary and productive failure. As Carroll et al. have theorised, "Failure occurs when the subject's process of inscribing themselves in the world – that is, the process of objectification – is interrupted or aborted […] failure is when objectification ceases to adhere." (2017:10). That is to say

that failure is what occurs when something does not perform that which is expected of it by someone or society. Materials do not fail so much as people accuse them of failing as they have an expected desire that they do something. In the case of the architects, the renders did not perform a utopian liveable Martian habitat when confronted with the expertise of the assembled specialists. When faced with the practical issues foregrounded by the collection of 'experts', the designs started to crumble. However, this is a problem the architects invited and wanted. This crumbling forced them to think about the technological challenges of the design, and as such, provide a trajectory for improvement and innovation to overcome practical problems.

However, these problems are overcome through a technological or architectural fix to an ideal that foregrounds a particular way of living. If the failure comes from a particular social position, then the solutions also come from a particular social position and therefore the technological fixes only fix and make liveable a particular conception of life. In a closed-loop architectural system, the design of life and liveability are limited by normative and psychosocial delineations of what it is to be human.

The architects ignored, to some degree, the reality of the biological human body and the extreme environmental conditions of Mars. It is not the case that the designers were unaware of the Martian ecology or the limitations of the human body, indeed many of the design elements were incorporated with these in mind. Yet, these design features were never going to be enough to allow living on Mars to flourish in the way recognisable to, say, Californian style Earth based living (see again the Stanford torus). There was perhaps a type of salvific idealism, that technology will solve any problem and redeem visions of the future. Underpinning the design of these habitats, and indeed all the prospective Mars missions, is the idea that human biology ultimately will be transcended. If the technology is furthered, the assumption is that life will follow. But this technological stoicism is precisely and ironically the attitude that creates the spaces of the ISS towards which the architects are so critically inclined. Technological structures collapse from utopian visions of salvation into structures that facilitate material and biology immediacy. So the challenge for designers and architects is how to design for life.

We also recognise, as the architects inherently know, that 'human living' often requires attention to more than the immediacy of the vital processes of biology. A focus solely on human biology certainly does not produce spaces conducive to well-being - and we acknowledge at least the architects' critiques of the ISS as respectful of needing 'more than the body in a tin can'. The architects' merger of utilitarian practicality with the 'social' fails because it is a utopian social. It's not the 'biosocial hybridity' that we argue a Mars habitat necessitates. Their vision is premised on an imagination for the future of humanity.

We suggest that the concept of utopia is a way to avoid the future of suffering. It ignores the 'materiality of the now' - so when one actually tries to make the building - when it comes time to actually put it together - their utopia necessarily fails. We show, however, that this failure is a process, *not* a critique. Such a failure is profoundly useful, and perhaps this is an inherent function of utopian visions - they are supposed to fail.

This is why it is ethnographically useful, say, to witness the disjunctures embedded within competing visions of the future and life. It is why, for example, it is ethnographically important to chart how the utopian vision of the Mars habitat is particularly marked by its relationship to landscape. It is why it is so offensive to a utopian designer to move into a lava tube, when it is so obvious to a radiation specialist. For the architect whose vision of the future is premised on a particular configuration of humanness, moving underground - losing the mastery of the landscape - is a form of death, while for the biologist, it is a form of life.

When utopian futures on mars become a set of technical design challenges, the ability for that utopia to offer a spatial or temporal fix to issues of the commensuration of all humanity into a whole 'we', 'us' is confronted through the material reality of making design choices and the constitutive exclusions that these choices involve. Maybe we can design a Martian home, but it won't be for everyone and it certainly won't be for Martians. Eventually the forms of life on Mars would have their own embodied experiences, their own perspectives on life and living. These may be radically different from what we recognize today. Is our anticipation of those futures adequate and how do we remain open to the radical forms of alterity that such futures may show us?

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