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Sociotechnical Imaginaries as Techno-Optimism: Examining Outer Space Utopias of Silicon Valley

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Abstract

Silicon Valley entrepreneurs have been investing in improving human spaceflight capabilities through the development of reusable rockets to greatly reduce the cost of orbital launches. One such entrepreneur is the controversial Elon Musk who projects a techno-optimistic vision of the future in which humans live on other planets, enabled by his company's technologies. This is a technologically utopian and libertarian vision that has implications for ongoing contestations about the future of Earth and humanity. For Musk and his investors and supporters, their vision is about how human action in outer space will transform things 'down here', bringing about positive social change. While many celebrate such business leaders of Silicon Valley, critical voices challenge their evasion of current global challenges. Musk's techno-optimistic visions can be illuminated by the concept of sociotechnical imaginaries that draws attention to how public debates about science and technology also often evoke feelings of excitement, adventure, disappointment and anxiety. Science fiction narratives and digital simulations play an important role in conveying to multiple publics the desirability and feasibility of such imagined futures. However, although exciting in ambition and design, Silicon Valley visions of outer space futures could impede the flourishing of humans and the planet.

Introduction

In the past two decades, several Silicon Valley entrepreneurs have turned their attention and resources to outer space and promoted a vision for future human expansion in the solar system. These include the founder and CEO of Amazon Inc., Jeff Bezos, who leads a rocket company called Blue Origin; Peter Diamandis, founder of the Singularity University and the X-Prize Competition, who has set up Planetary Resources Inc. with the aim to mine asteroids; and Elon Musk, co-founder of PayPal and now CEO of SpaceX. Musk's vision is for SpaceX to develop technologies to facilitate the human settlement of Mars.

They are not the first to articulate such visions. Since at least the 1600s, scientists, engineers, writers and many of their publics have imagined visiting or even living on other planets. In

the last century, the US and Russian Space Programmes, representing "modernity's grand aspirations and adventures with science and technology" (Jasanoff 2015: 5), promised a radical transformation of human society: that, by now, people would indeed live on other planets. Whether business leaders in Silicon Valley will succeed in realizing their visions is an open question. In any case, my purpose is not to assess the feasibility or otherwise of such visions, but to critically examine how Silicon Valley entrepreneurs and their supporters talk about their investment in human spaceflight technologies, how they have sought to garner support for these visions, and how they are contested in the context of significant and unresolved global challenges. While many celebrate pursuing a future in which human beings explore and inhabit other planets, others question whether investing in making this future a reality is little more than a distraction or a pernicious form of escapism.

How do claims and counter-claims about the future of humans in outer space also articulate competing visions of Earthly futures? How are they part of wider debates about technological innovation and planetary change? By exploring these questions, my paper analyses how outer space is 'produced in and through Earthly regimes of power' (Macdonald 2007: 610). I develop conceptual frameworks from the STS (science and technology studies) literature to analyze how Silicon Valley visions are in thrall to opposing futures of sociotechnical optimism and Anthropocenic pessimism, which emphasizes instead the prospect of ecosystem and societal collapse.

In the next section, I situate my work in ongoing debates and set out the conceptual tools that I will use in the paper to discuss contested outer space utopias in Silicon Valley in the context of these opposing but interlinked futures of Earth and humanity.

Outer space and sociotechnical imaginaries

My contribution is situated in what anthropologist Messeri (2016) calls 'social studies of outer space', which treats outer space as a 'sphere of the social' (Macdonald 2007), and is concerned with the cultural and social meanings, economics, and politics of human activities in outer space. Social studies of outer space is multidisciplinary, drawing on anthropology, geography, sociology, STS, and literary studies. In broad terms, it critically analyses relations between the "out there" and the "down here", to echo Macdonald (2007: 610). For example, the geographies of Earth's orbital spaces are linked to the exercise of national military power and to everyday life through the use that mobile devices make of the GPS (global positioning system).

The social studies of outer space is also concerned with investigating how people 'derive meaning from outer space' (Dunnett et al 2019) in a variety of ways, whether through amateur astronomy, popular cosmology, science fiction literature and film, or membership of citizen advocacy organizations. Indeed, we should recognize that in many cultures and at many times, the relation between individual and collective lives and the cosmos has been an important feature of human experiences (Dickens and Ormrod 2007). Relatedly, scholars in this field also consider outer space as a significant site for imaginative practices, such as visualizing other planetary landscapes, or producing designs for future spacecraft or human habitats (McCurdy 2011). As such, outer space has been the subject of speculation and future-making (Bainbridge 1976, Shukaitis 2009, Parker 2009, Valentine, 2012, Kilgore 2003).

That last element relates to recently emerged capitalist ventures for commercializing space. Valentine (2012: 1047) argues that they promote a vision of how 'entrepreneurial activity will radically and positively transform the future evolution of society and of our species itself by establishing human settlements in the solar system and beyond'. These ventures, he argues, must be appreciated as thoroughly utopian: they are led by people who are not only wishing to make money but also to change the world. While there are several ventures started by actors associated with Silicon Valley, I focus on Elon Musk's company SpaceX as exemplifying the utopian aspects of these new capitalist ventures in outer space.

I analyse the visions and practices of this company through the analytical framework of sociotechnical imaginaries. As STS scholars argue, the concept of imaginaries draws out the significance of values in public debates about science and technology.

> [Interests/ideologies] have proven to be limited theoretical tools for pursuing the normative dimensions of science as they operate primarily in a cognitive register—neglecting affective dimensions. Moreover, both concepts are linked to distortion, misrepresentation, and manipulation, whereas invoking the imaginary allows for consideration of the productive—of expectations, hopes, and dreams, as well as fears—which are increasingly attracting attention (McNeil et al., 2017: 457).

To discuss the relationship between national identity and state-led technoscientific projects, Jasanoff and Kim's (2009) have elaborated the concept of 'sociotechnical imaginaries'. More recently they refer to how corporations, social movements and scientific communities may also be sites in which sociotechnical imaginaries are enacted (Jasanoff and Kim 2015).

Jasanoff (2015:19) defines sociotechnical imaginaries as '"collectively held and performed visions of desirable futures" (or of resistance against the undesirable), and they are also "animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology".

Therefore, sociotechnical imaginaries both project an image of the kind of society that sociotechnical innovation can bring into being and the kind of society that is needed for innovation to happen. Implied in imaginaries are 'aspirational and normative dimensions of social order' (Jasanoff 2015: 5), in other words, commitments to how life ought to be lived and what constitutes the 'good life'. This brings into view the matter of utopia, which sociologist Levitas (2011) defines as the desire for a 'better way of living and being'. This desire can find expression in 'technological utopianism' as well, which Howard Segal (1986: 149) defines as 'the belief in technology [..] as the means of achieving a 'perfect' society in the near future'.

Klaffke (2015: 6) argues that technological utopianism is manifest in Silicon Valley, which is shaped by 'three ideologies: the Californian ideology, cyber-libertarianism, and Singularitarianism'. Together, these inform the design and development of technologies and the projected futures that entrepreneurial figures in Silicon Valley publicly perform to win the support of investors, collaborators, users, workers, and other potential allies. Of these three, Barbrook and Cameron's (1996: 49) notion of the 'Californian ideology' is especially pertinent for this paper as not only does it express an optimistic vision of the future, but also combines 'technological determinism and libertarian individualism'.

As Levitas (2011: 221) notes, there is always a degree of ambiguity about utopia: not all desires for a 'better way of living and being' will be met: as she explains, 'utopia expresses and explores what is desired; under certain conditions it also contains the hope that these desires will be met in reality, rather than merely in fantasy'. In other words, not all desirable futures are also hopeful futures. To give hope, Levitas contends that utopias must also address the practicalities of how they would come into being. We can see that the past is full of failed visions of desired futures. Indeed, as Jasanoff (2015: 5) observes, 'imaginations of desired futures also correlate with [..] with the obverse— [..] the failure to innovate'.

Furthermore, by referring to how sociotechnical imaginaries express 'visions of desirable futures', Jasanoff (2015: 4) indicates that investments in technoscience are typically characterized by 'positive visions of social progress'. In his classic work, John Bury (1920: 2) defines progress as 'the idea [..] that civilization has moved, is moving, and will move in a

desirable direction'. Therefore, the notion of progress suggests a historical process that is in effect 'locked-in': 'it consists of irreversible changes in one direction only, and that this direction is towards improvement' (Pollard, 1968: v).

On the other hand, scholars working with the framework of sociotechnical imaginaries also wish to challenge deterministic narratives of progress, to show how there is not one but multiple imaginaries and how each are open to resistance and contestation (Bowman 2015, Felt 2015, Hurlbut 2015). As Jasanoff (2015: 339) reflects, 'sociotechnical orders are not natural' and 'the seen reality is not the only one about which we can dream'.

When it comes to progress for example, authors question whether we assess it against the past in terms of the growth in knowledge or the 'moral and spiritual condition of humanity', or in terms of what is expected of the future in terms of the goal of 'ever-greater perfection of human nature' (Nisbet 2009: 5). As Bury (1920: 2) observes: 'it cannot be proved that the unknown destination towards which man [sic] is advancing is desirable'. Since the end of the 1960s, many social actors and groups have highlighted the 'perils of progress' (Ashton and Laura 1998) and the unintended (if not always unanticipated) consequences of technoscientific developments.

Social scientists in particular have challenged whether societies are moving in a 'desirable direction', guided by 'positive visions of desirable futures'. Instead, Berardi (2011: 126) argues that 'the future' – as it was constructed in the last century based on notions of progress towards improvement, enrichment, and human mastery over nature – is over: he claims that people 'have lost all trust in [..] the future: [it] no longer appears as a choice or a collective conscious action, but is a kind of unavoidable catastrophe that we cannot oppose in any way'. Berardi's work is one example of what Urry (2016) calls the 'new catastrophism' in social science, which imagines dystopic futures of societal collapse, resource depletion, mass extinctions, and climate change. Such catastrophism is a notable feature of the 'Anthropocene condition' (Lorimer 2016) – the claim that humanity (or at least a certain section of humanity), through economic and sociotechnical activities, has become a geophysical force with far-reaching impacts across both space and time. These activities will produce 'future planetary conditions [..] radically different from the past emerging on a planet marked by tipping points, positive feedback loops and spiralling and uncontrollable trajectories of nonlinear change' (Lorimer 2016: 127).

Others challenge what they see is the 'fear-based' narrative of the Anthropocene and press the case instead for finding alternatives, overcoming any sense of catastrophic fatalism

(Lidskog and Waterton 2016). Jasanoff, too, also offers the more optimistic parenthetical addition that in some instances sociotechnical imaginaries might also be collectively held and performed resistances to undesirable futures. Low carbon innovation imaginaries for example offer resistance to energy intensive, 'high carbon' capitalism, unchecked climate change, and involve both technological changes and the cultivation of alternative models of social life in which values, attitudes, and everyday practices would be radically different.

In sum, STS work on sociotechnical imaginaries brings a new perspective to scholarship in the social studies of outer space that is concerned with the role of imaginative practices in technological change and future-making. I draw on the analytical framework of sociotechnical imaginaries to explore what I call the 'extraplanetary imaginaries' of Silicon Valley entrepreneurs and investors (see Tutton 2018). Rather than being limited only to businesses located in a particular place, my use of the expression 'Silicon Valley' refers to what Foucault has called an 'attitude' – 'a mode of relating to contemporary reality, a way of thinking and feeling; a way, too, of acting' (in Rabinow, 1984: 39) – rather than being solely a geographical descriptor.

SpaceX does not have any premises in the Silicon Valley area, but has strong cultural links with it, with its leaders and investors sharing in the 'Californian ideology' (Barbrook and Cameron 1996). Therefore, these 'extraplanetary imaginaries', as collectively shared and publicly performed visions of a future in which human expansion in the solar system will produce a 'better way of living and being' 'out there' and 'down here', are infused with technological utopianism and libertarian individualism.

Accordingly, in contrast to those social scientists who see the twenty-first century in terms of decline and collapse, Silicon Valley actors articulate a confidence that society is moving in a desirable direction; they are committed to the narrative of progress, and assume that their technology is a force for good, making the world better for everyone (Giannella 2015). They are, to use the wording of this special issue, 'techno-optimists', hopeful and confident that their technological innovations are making and will continue to make a positive social change. Their optimism stems from their sense of agency to shape the world as they see fit (Polak 1973). However, extraplanetary imaginaries in Silicon Valley are also haunted by pessimistic futures, such as the failure to innovate and the possibility of planetary catastrophes. I am interested therefore in this interplay of optimistic and pessimistic registers in which these extraplanetary imaginaries are expressed.

Furthermore, I explore some forms of possible resistance to these imaginaries, again by turning to the STS literature, discussing the work of Donna Haraway (2016) on the Chthulucene (as a rival concept to and criticism of the Anthropocene), Bruno Latour (2013) on 'Earthboundedness', and Andrew Russell and Lee Vinsel (2017). In their different ways, these authors offer up critical approaches that challenge 'extraplanetary imaginaries' and indicate possible alternatives, as I discuss in the final section of the paper.

In focusing on Musk and his company SpaceX, I am mindful of Jasanoff's (2015) comment that sociotechnical imaginaries are more than a single individual's vision or dream; they come to matter when they gain a collective force, drawing on material and symbolic resources. There is a long and varied history to 'extraplanetary imaginaries' (beyond the scope of this paper) and SpaceX is but one among several commercial entities (from Blue Origin to Lockheed Martin and Boeing), state actors, and citizen groups who are actively articulating future visions of humans in outer space.

Furthermore, I avoid dwelling on the personality of Elon Musk. In various media he is represented as, on the one hand, a 'visionary' or 'saviour' like figure (see Vance 2015) and, on the other, as vainglorious, with a tendency to make unsubstantiated claims on Twitter that bring himself and his companies into public disrepute. In my analysis, I am concerned more with how Musk's pronouncements and those of investors and supporters of his company's activities, borrow from and add to existing repertories of extraplanetary imaginaries.

I therefore focus on narratives and metaphors (especially those drawn from science fiction), alongside visualizations and digital simulations, tracing how these powerful actors are actively seeking to shape publics' imagination. I base my analysis primarily on a corpus of media texts (n=263) comprising press releases, magazine articles and other news pieces published in the 2008-2017 period in the English language (generated from a search of Nexis). This corpus gives a good insight into the key claims and promises made by Musk and other key Silicon Valley figures about their initiatives to develop new human spaceflight capabilities. In addition to these textual sources, I also discuss the role that visual representations play in lending authority to SpaceX and its vision of the future. Before I turn to this material, I start by acknowledging how extraplanetary imaginaries are performed not only through text or image but also through technical, legal, political and economic practices. I therefore outline the place of SpaceX in the wider technopolitical economy of contemporary aerospace.

SpaceX in Context

In 2002, Musk established SpaceX, the stated mission of which is 'to revolutionize space technology, with the ultimate goal of enabling people to live on other planets' (SpaceX 2018). In his biography of Musk, Vance (2015: 219-20) describes the company as a 'tight-knit family', a 'free radical', and as a 'hip, forward-looking place that's brought the perks of Silicon Valley – namely frozen yoghurt, stock options, speedy decision-making, and a flat corporate structure – to a staid industry'. While the SpaceX vision focuses on Mars, the company has also become a disruptive force in the US orbital launch sector that has been dominated since 2005 by Lockheed Martin and Boeing's partnership, United Launch Alliance (ULA).

[Insert figure 1 around here] Figure 1: SpaceX Dragon capsule in Earth orbit, 2014 (Image courtesy of SpaceX)

The US state plays an important role in funding and regulating spaceflight. American military and intelligence agencies see domination of orbital space as vital to the exercise of US global power. To that end, the US Air Force (USAF) had helped to broker the ULA partnership, to ensure that they had continued access to orbital space, although at an increasing cost to the federal budget (Berger 2017). Moreover, the development and manufacture of spaceflight launch systems and facilities guarantees US expertise in the sector, secures its legacy as the preeminent spacefaring nation, and provides employment across multiple US states.

Therefore, for SpaceX to grow, Musk focused efforts on the US state as a key customer for his company's rockets. National security launch contracts would provide significant revenue for his company and Musk made legal and political challenges to the US Federal Government's contract with ULA. At a US Senate hearing in 2014, he challenged a new 'block buy' contract that the USAF was prepared to grant ULA for launches up to 2020 (Berger 2017). To the senators, Musk claimed that ULA received 'subsidies' and 'government welfare' and that these payments meant that SpaceX could not compete on equal terms for national security launch contracts. He then filed a lawsuit to prevent the block buy contract, which led the USAF to certify SpaceX's rocket the Falcon 9 for national security payloads, and to open up a number of the block buy launches to competitive tender.

In 2014, SpaceX won a contract to deliver its first national security payload to orbit. The debate about what counts as a 'subsidy' is not one for this paper; what is clear that both ULA and SpaceX depend on the awarding of high-value contracts from the US military. Along with other firms such as Blue Origin, they will be competing for future military missions and

for funding to enable them to develop new rocket propulsion systems using American-made as opposed to foreign sourced technologies (Berger 2017).

However, in addition to military or national security launch contracts, SpaceX has also benefited greatly from NASA's contracts to fly cargo resupply missions to the International Space Station (ISS). In 2014, it was given US$2.6 billion to develop a crew version of its Dragon space capsule, which had its first demonstration flight to and from the ISS in early 2019. The aim is that NASA will no longer depend on Roscosmos and its Soyuz spacecraft to ferry crew to the ISS and will instead use either SpaceX's Crew Dragon capsule or Boeing's Starliner. Beyond ISS flights, NASA is also working with Boeing on developing the SLS (Space Launch System) and Lockheed Martin on the Orion crew capsule for lunar missions in the next decade. What role if any SpaceX or Blue Origin will play in realizing the Trump Administration's public commitment to NASA landing on the moon again in 2024 is not clear at this time of writing.

In sum, SpaceX has established itself as a serious competitor to traditional aerospace companies for US crew and cargo orbital launches. Its launch costs are cheaper than competitors such as ULA, the company is willing to make legal challenges when it loses contracts, engage in political lobbying at the US Congress, and is seeking to expand into the global commercial launch market. In that respect, SpaceX attempted to influence ongoing trade negotiations between the US and the EU, criticizing European Space Agency (ESA) and French Government support for Arianespace, whose Ariane rockets are a competitor to the SpaceX Falcon 9. In the past, Arianespace and Roscosmos captured about 80% of commercial launches, now, it is reported, SpaceX is taking 50-66% of new contracts in this sector (Berger 2018).

One key technical difference between SpaceX and these competitors is that the former is actively developing and using reusable rocket stages. In 2015, SpaceX successfully returned the first stage of its Falcon 9 rocket and achieved a series of reflights of returned first stages for launches during 2017. The company aims for the first stages to be re-used up to 100 times before retirement (Thompson 2018). With greater reusability comes the prospect of radically reducing the cost of orbital launches. However, some uncertainty remains about the reliability of reusable rocket stages at least for certain payloads (Erwin 2018). Despite this, SpaceX sees that reusability is vital to the company's vision of an extraplanetary future. Musk uses the airline industry as a model for what SpaceX should achieve with orbital spaceflight: that travel to orbital space should take place using rapidly reusable vehicles that reduces the current cost hundredfold.

[Insert figure 2 around here] Figure 2: SpaceX boosters landing after flight (Image courtesy of SpaceX)

As Sage (in Dunnett et al 2019) suggests, we should not only address current challenges and future promises of human spaceflight from the perspective of the state or capital, but also from that of labour. In common with many other Silicon Valley leaders, including Jeff Bezos, Musk has publicly expressed strong opposition towards unions. SpaceX comprises a non-unionized workforce, which Vance (2015: 120) characterized in 2015 as typically made up of 'young, male overachievers'. In contrast, ULA has a unionized workforce, represented by the International Association of Machinists and Aerospace Workers (IAMAW). The public Facebook page of IAMAW Lodge 44 (https://www.facebook.com/iamaw44/) located in Alabama celebrates the achievements of US space exploration by emphasizing the work of union members, seeing them as the 'backbone to everything aerospace' (15 February 2019).

At stake in the rise of SpaceX then, are also questions about the conditions of Earthly labour, the rights and welfare of workers charged with designing, manufacturing and preparing vehicles and facilities for orbital launch. When in December 2018 Tesla workers sought to unionize, Lodge 44 reached out to SpaceX employees, stating 'past due. SpaceX employees, call us, message us. We're here for you' (18 December 2018). Further, in the wake of launch explosions of the Falcon 9 in 2016, an IAMAW Facebook post suggested that this was an inevitable outcome of the long hours culture at SpaceX and a 'unhealthy and unsafe' working environment, which amounted to being a '21st century sweatshop'. The post's author noted that: 'space exploration takes more than cheap labor, deep pockets and friends in Congress' (1 September 2016).

There is well documented criticism of the SpaceX workplace environment and culture. Vance (2015) discusses the intense pressure under which employees worked during the first ten years of the company, the high turnover of staff, and the very long hours that employees put in, especially to meet deadlines that Musk himself imposes on the completion of complex engineering tasks. Further evidence for this comes from the anonymous reviews submitted by current or former SpaceX employees to the recruitment site glassdoor.com, many of which cite the long hours culture and the lack of work/life balance as a negative feature of their experience of the company (see also Bloom 2017).

For Musk, the vision justifies the long hours employees work: as he tweeted in November 2018, 'nobody ever changed the world on 40 hours a week'. Many of the glassdoor reviewers also refer positively to the opportunities they have to be a 'part of history', being 'associated with the future', and identify strongly with the SpaceX mission. Therefore, Musk and SpaceX have apparently been successful in attracting well-qualified employees who find the vision to be persuasive and are prepared to work the very long hours required. I now turn to consider this vision in more depth.

Elon Musk on Mars

Musk's vision is for humans to become a "multiplanetary species" by settling Mars. He first began to organize around this vision in 2001 when he became involved with the advocacy group, the Mars Society, briefly joining its Board of Directors. After resigning that position, Musk then set up the Life to Mars Foundation with this long-term friend Adeo Ressi (Vance 2015). This move was later cast as an attempt to 'show the world that two guys with money and vision could reach Mars, and that it wasn't that bad a place' (Junod 2012). Musk set up SpaceX the following year. In common with others who advocate for the human settlement of Mars, Musk prefers this planet as a destination because of certain similarities with Earth: the presence of an atmosphere, the length of the Martian day (24.5 hours), decent sunlight, comparative land mass, and the presence of water (trapped in ice beneath the surface). Significant differences remain however: the air is not breathable, gravity is 37% of Earth gravity, and there is no global magnetic field. As a consequence, both Musk and the President of SpaceX, Gwynne Shotwell, have described Mars as a 'fixer-upper of a planet' (Brueck 2015).

Musk's plan is only the latest of more than a thousand such plans which have appeared since 1952 (Portree 2000). In 2016, when Musk addressed the International Astronautical Congress, he focused a great deal on the economics of spaceflight to Mars. He claimed that using existing approaches, the cost of sending one person to Mars would be in the order of US$10 billion. This is simply not affordable, so his goal is to reduce that cost to approximately US$200,000 per person. This is to be achieved through developing a fully reusable spacecraft, now known as Starship with a Super Heavy booster that would be used for orbital re-fuelling, and developing a method and system to manufacture propellant from the Martian atmosphere for the return journey. Together, these innovations would reduce launch weight and allow larger spacecraft payload. While there is more one could say about the technical challenges involved, my focus is on the different modes in which the extraplanetary imaginary of Elon Musk and SpaceX is performed and expressed.

[Insert figure 3 around here] Figure 3: The "Starman" payload launched on the Falcon 9 Heavy demonstration launch, February 6, 2018. (Image courtesy of SpaceX)

As Jasanoff (2015) relates, performance is an important element to sociotechnical imaginaries, pointing to public experiments to which others pay 'witness', or staged moments when technoscientific objects play a role in the political performance of collective belonging. I extend this element of performance to include technological demonstrations (to which many pay witness) and the production of visualizations. Joseph Lampel (2001) relates how companies often stage 'technological performances' to persuade publics, including potential investors, about the value of a new technology in dramatic and striking ways.

SpaceX has staged a series of publicly performed demonstrations of its launches vehicles, with each launch becoming a highly mediatized event, none more so than the first Falcon Heavy launch in February 2018 that sent a red Tesla car with a space-suited figure (aka "Starman") sat in the driver's seat out into the solar system. A four-hour long YouTube video showing "Starman" moving away from Earth has, at the time of writing, been viewed 16.6 million times (12 April 2019).

The landing of rocket stages on drone ships and landing pads has also become a spectacle in itself. SpaceX videos on social media of returning boosters landing on their pads can attract as many views as the actual rocket launches themselves. In media reports, each successful return and landing of a spent rocket stage is read off against the ultimate aim of SpaceX 'to enable people to live on other planets'.

As Lampel (2001: 315) notes, in cases when the technologies or machines do not yet exist, 'dramatic performances are [..] designed to demonstrate the feasibility of an idea', which can take the form of visual simulations. Across YouTube, Twitter, and Instagram, SpaceX combines images of actually achieved launches and simulations of future flights. On the main SpaceX website, there is an entire section called 'Making Life Multiplanetary' which features video, simulated images and technical specifications about such aspects as payloads, propulsion, and atmospheric entry on Mars. This part of the website gives much attention to Starship, which the company intends to use for flights to the moon and Mars. Along with other videos that the company has made, these elements are all examples of what Samuel Kinsley (2010) calls 'vision videos', which give detail to imagined sociotechnical activities, lending projected technologies a degree of material authenticity.

[Insert figure 4 around here] Figure 4: Simulated image of Starship on approach to Mars orbit (Image courtesy of SpaceX)

In sum, SpaceX's technological performances, both actual and simulated, work together to persuade publics that spaceflight could become more like an everyday activity, and that SpaceX in particular has the technical capabilities to make that happen. However, as McNeil et al (2017: 457) note, attending to imaginaries means considering more than cognitive dimensions, it's also about affective dimensions such as 'expectations, hopes, and dreams, as well as fears' in relation to science and technology. These technological performances are also designed, I would contend, to engender positive, affective responses such as excitement or wonder.

This being said, although millions of people watch SpaceX videos on social media platforms, we know little at the moment about how diverse public groups respond to these technological performances. This requires further research. Pending such work, in what follows, I analyze the different narratives and metaphors that Musk, his investors and supporters use to express their vision of the future, as a way to further explore the affective dimensions of their extraplanetary imaginaries.

As Robert Markley (2005: 2) argues, Mars has been the 'screen on which we have projected our hopes for the future and our fears of ecological devastation on Earth'. The first narrative is an optimistic one of adventure and expansion, of escape, and the other is more ambivalent in tone and highlights risks and dangers.

Progress and Escape

Science fiction authors and engineers have indeed imagined Mars as a better place, somewhere to establish a 'better way of living and being' (Levitas 2011). Organizations such as the Mars Society contend that the effort to establish human society on Mars would drive technological innovation, scientific progress, and economic growth for humanity on Earth. In media interviews, Musk refers to the 'spirit' of human – or, more specially, American – exploration. He states that:

> Establishing a self-sustaining base on Mars would be the most exciting adventure I could imagine for humanity. That's the kind of future that I want us to have and I think a lot of people want us to have, particularly Americans. (Ward 2012)

This is coupled with a sense of disappointment that previous promises about the human adventure in outer space have not been fulfilled. Musk contends that:

> A lot of people feel more than a little disappointed that the high-water mark of human exploration was 1969. The dream of human space travel almost died for a lot of people. SpaceX is about restoring that dream. (Ward 2012)

As Jasanoff argues (2015: 329) this move is characteristic of how sociotechnical imaginaries are embedded through 'processes of collective "remembering" of events [..] in order to construct meaningful translations from the pasts that were, to presents that are, to futures as people would like them to be'. Musk's statement is typical of the way that supporters of human spaceflight recall the Apollo Program with a potent mix of excitement and disappointment, remembering it as a pivotal moment of human achievement but also the point at which their preferred version of the future was in effect cancelled. Musk argues that his company will restart progress, and set humanity back in a desirable direction.

In articulating a narrative of progress, Musk presents his vision for humans becoming a multiplanetary species as the inevitable outcome of an evolutionary process. He describes how:

> There have only been a half dozen genuinely important events in the four billion year saga of life on Earth: single-celled life, multicelled life, differentiation into plants and animals, movement of animals from water to land, and the advent of mammals and consciousness. The next big moment will be life becoming multiplanetary, an unprecedented adventure that would dramatically enhance the richness and diversity of our collective consciousness. (Anon 2008)

Therefore, the pursuit of an extraplanetary future becomes naturalized as part of a linear sequence of steps in life's evolution, with the implication that this final step will be a force for good in terms of improving our 'collective consciousness'. However, to reach that future, entrepreneurs such as Musk must first overcome how societies have become risk-averse – a complaint that Peter Diamandis and many other outer space advocacy groups also make (World Affairs Council 2015). This is attributed to the power of self-serving bureaucratic systems. In contrast, Musk is frequently represented as someone who is prepared to take risks that many other people would not take to pursue his vision (Junod 2013).

For Peter Thiel, one of SpaceX's investors and co-founder with Musk of PayPal Inc., this 'next big moment' when life becomes multiplanetary does not only signify another step in evolution but also the chance of escape. Thiel (2009), a self-declared libertarian, laments that there are no 'truly free places in the world' and to escape 'must involve some sort of new and hitherto untried process that leads us to some undiscovered country'. Although he rejects seeing himself as a technological utopian, Thiel does consider that investment in new technologies 'may create a new space for freedom', amongst which he includes rocket development. For Thiel, outer space is a utopian space in which to imagine 'a limitless possibility for escape from world politics', which yokes together both a pessimistic perspective on the present-day and an optimism about how space technology could produce a different society.

Hedge

As well as narratives of progress and escape, Musk and others propose that the effort to settle Mars 'would also serve as a hedge against the growing-and-myriad threats to our survival' (Anon 2008). These existential threats are imagined in the form of natural disasters as well as human-made ones such as bioengineered viruses, global warming or a third world war. Appearing at the 2018 South by South West Film Festival (SXSW) in Austin, Texas, Musk claimed that there was 'some probability of another Dark Age' especially if there a worldwide conflict, and justified dedicating resources to constructing either a Mars or Moon base to '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' (Wall 2018).

In media interviews, Musk often says that: 'the thing that Mars really represents is life insurance, ensuring that the light of consciousness is not extinguished, backing up the biosphere' (Grossman 2016). In one interview, Musk describes Mars as being a 'backup drive for humanity'. Peter Diamandis, founder of Planetary Resources Inc, uses similar language when speaking about how 'we have the moral obligation to back up the biosphere, take it offplanet, and to give ourselves the safety of ubiquity' (Greenwald 2012).

Musk appears influenced by his reading of Isaac Asimov's Foundation series, in which the author tells the story of the fall of a galactic empire that ushers in a dark age. In an interview for the Rolling Stone magazine, Musk observes that: "It's sort of a futuristic version of Gibbon's Decline and Fall of the Roman Empire. Let's say you were at the peak of the Roman empire, what would you do, what action could you take, to minimise decline?" (Strauss

2017). In response, Musk sees a parallel for our time, that the opportunity to realize his desired vision of the future could be imperilled:

> There could be some series of events that cause that technology level to decline. Given that this is the first time in 4.5bn years where it's been possible for humanity to extend life beyond Earth, it seems like we'd be wise to act while the window was open and not count on the fact it will be open a long time. (Smith 2016)

Therefore, influenced by science fiction narratives and other catastrophic accounts of the future, Musk presents multiplanetary life both as the 'next step' in evolution and imperiled by the possibility of global conflicts or disasters.

Of course, the metaphor of 'backing up' is one that one might expect to hear from Silicon Valley entrepreneurs: a whole new business has emerged to provide the software and infrastructure to back up data in cloud storage services. Musk and Diamandis ask us to see the merit in doing something similar with humanity as well. From this perspective, Mars constitutes the ultimate offshore hedge fund: its settlement offering a way to avoid death and destruction.

There is little new in this: as Romanyshyn (1989: 23) remarks, the dream of spaceflight is the escape from death on a planet that humans have 'wired for destruction'. We can trace this dream to Russian Cosmism of the early 20th century that expressed a commitment to rejecting natural death, the pursuit of immortality, and life in the cosmos (Groys 2018). The Cosmist philosopher Nikolay Fedorov (1828-1903) advanced what he called the 'philosophy of the common cause' - this cause being the overcoming of death (see Koutaissoff 1984: 98). United in this cause, human beings would work together and establish a 'brotherly union of all humans [which] would enable them to overcome gravity, travel through space, migrate to heavenly bodies' (Koustaissoff: 99).

The connections between Russian Cosmism and Silicon Valley are worthy of further explication as today, amongst many Silicon Valley entrepreneurs, there is similar concern with avoiding death and attaining immortality. As Lanier (2013) relates, many are currently pursuing two technological solutions to counter death: media technology and biology (that we will be able to upload our consciousness into the cloud, and that we will be able to reverse or delay ageing). The proposition that Mars could be a 'back up drive for humanity' also shows that for some Silicon Valley entrepreneurs space transportation technology also

promises another form of immortality – ensuring that the 'light of consciousness' does not go out, as Musk says (Grossman 2016).

Contesting and Resisting Extraplanetary Imaginaries

Thus far I have drawn on the framework of sociotechnical imaginaries to analyse how Musk as CEO of SpaceX and some of its investors have advanced their vision of a desirable future in which humans become a multiplanetary species. However, as Jasnaoff and others have argued, imaginaries are open to contestation. While much of the media coverage is positive, even celebratory, there are also critical voices who express skepticism about the technical feasibility or economic viability of Musk's vision. The former Director of the Space Policy Institute at George Washington University, John Logsdon, characterizes Musk's proposals as being on the 'edge of fantasy' in terms of their timelines, and observes that he has focused on a great deal on transport to Mars and less on the practicalities of surviving on the planet for any length of time (Cofield 2016).

In addition to practical considerations, others have challenged Musk's framing of why human beings should establish a presence there. For instance, Musk's corporate rival Jeff Bezos is reported as saying that Musk's proposition that Mars should be regarded as a 'back up' planet is 'unmotivating' (Kosoff 2018). By contrast, Bezos fashions his initiatives in outer space as the means to protect Earth from further deterioration, as opposed to finding somewhere else humanity can find a safe haven (Kosoff 2018). Astrobiologist Lucianne Walkowicz (2015) also challenges the 'back up' narrative, likening it to the captain of the Titanic telling its passengers that the real party will be on the lifeboats later, after the ship has sunk. Walkowicz is one of the leaders behind a recent initiative called 'Decolonizing Mars' that aims to challenge the preponderance of colonial narratives to project the desirability of human activity in outer space, claiming that this 'colonialist framework [..] reproduces past harm from humanity's history on Earth' (Decolonizing Mars 2018).

To avoid a colonial discourse of exploitation and appropriation, others have sought to articulate alternative ways to imagine how human beings might venture into space and establish their presence on other planets (Grinspoon 2004, Oman-Reagan 2015, Wright and Oman-Regan 2018). Although it is beyond my scope in this paper to consider the relative merits of such alternative forms of language, they attest to how dominant sociotechnical imaginaries of the kind I am concerned with here, which connect imagined pasts to imagined futures (Jasanoff 2015), are open to resistance and contestation.

In the final part of this paper, I consider what STS offers to the task or contesting and resisting Silicon Valley's extraplanetary imaginaries. I now return to the STS literature to discuss further insights into these imaginaries from the perspective of debates about technological innovation and planetary futures.

I begin with Andrew Russell and Lee Vinsel's (2017) intervention into the debate about Musk's plans. These authors are engaged in ongoing debates about the relationship between innovation and maintenance. They are part of a network called 'The Maintainers', which 'fosters and promotes action research into maintenance, repair, infrastructure, and the mundane work that keeps our society going' (see http://themaintainers.org/about-us).

Russell and Vinsel's (2017) argument reflects their concerns about the importance of maintenance and repair: they see Musk as a wealthy individual who wants to 'innovate and leave Earth, rather than take care of it' and that 'like so many of his peers in the innovating and disruptive classes, Musk prefers to dwell in fantasy and science fiction, safely removed from the world of the here and now'. Their point is precisely about planetary challenges and the appropriate response to them: create a back-up somewhere or work to ameliorate the conditions that would prompt the need for one in the first place. Russell and Vinsel are asking us to consider whether SpaceX's (and Blue Origin's) attempts to improve the reusability of rockets constitute a form of responsible innovation (a discussion for a future paper).

They view Musk's project as being little more than impracticable and misguided fantasy and a mis-use of limited resources. Russell and Vinsel (2017) refer to Musk as a utopian, who, 'repulsed by the world we all share, [..] dreams of a place that does not exist'. Here, they use the term utopia in a derisory way, and see that the desire for a 'better way of living and being' should be pursued with initiatives focused on more Earthly concerns. They argue that there are far better ways to spend the money that Musk is hoping he will attract to fund the human settlement of Mars. They point to how US$1.5 billion would clean up the lead-contaminated water in Flint, Michigan.

Arguments about whether it is justifiable to spend large sums of money on outer space exploration, when so many live in poverty and inequality remains rampant, have been heard at least since the Apollo Space Programme. Russell and Vinsel's provocatively named piece 'Whitey on Mars' recalls Gil Scott Heron's performance-poem of 1970, 'Whitey on the Moon', in which he laments his lack of access to healthcare as an impoverished African-American, while white men are funded with billions of dollars to walk on the moon.

They conclude that while the effort to go to Mars ‘catalyses something deep inside the human imagination’ and that the ‘thirst for adventure, to reach for the stars, and to pursue the sublime is worthy, perhaps commendable […] it is also at least as removed from the needs and experiences of humans, and Musk’s own society [..] as Earth is from Mars’.

Although she does not address Silicon Valley's interest in outer space, Donna Haraway's (2016) recent work on planetary futures is also relevant here. Aspects of Russell and Vinsel’s critique of Musk’s plans resonate with Haraway’s discussion of what she calls ‘staying with the trouble’. Haraway (2016: 1) observes that: ‘we —all of us on Terra — live in disturbing times, mixed- up times, troubling and turbid times’, and that, in such times, ‘many of us are tempted to address trouble in terms of making an imagined future safe, of stopping something from happening that looms in the future, of clearing away the present and the past in order to make futures for coming generations’. People invest their optimism in the dream of a better time when, Haraway counters, they should seek to be 'truly present': to attend to their present moment, to address the matters that confront them and their peers today.

Both Musk and Bezos appear to want to 'address trouble' by making futures that clear away the present and the past. They are doing this of course through the significant financial gains that they have accrued from the very system that is implicated in making what Haraway (2016: 3) calls the ‘horrors of the Anthropocene’. They utilize the benefits of labour practices and tax arrangements, which have courted controversy (Shepherd 2018).

Bruno Latour (2013) is also dismissive about anyone investing hopes or money in outer space. In *Facing Gaia: Eight Lectures on the New Climatic Regime*, a series of lectures that he delivered in 2012, Latour offers up the notion of Earthboundedness, which I read as a form of resistance to extraplanetary imaginaries. While billions might be spent to send a few individuals to dead planets, Earth remains the only live one, Latour (2013: 56) observes, concluding that: ‘where things will happen will be down here and now. Don’t dream anymore […] You won’t escape to outer space. You have no other abode than down here, the shrinking planet’. For Latour, the Anthropocene demands that we give up dreams of outer space and appreciate that we are Earthbound: both in the sense that there is ‘no escape route except back on Earth’ – that the answers to our problems lie here on Earth - and that we cannot exit to another world: we are, Latour (2013: 56) says, ‘imprisoned in [Earth’s] tiny local atmosphere’.

In their different ways, these authors challenge the apparent optimism of imagined new expansions in outer space as representing a meaningful or viable way to escape from or guard against predicaments of the contemporary world. For Levitas, utopia is a matter of desire and hope, haunted always by (im)possibility. To this, I add another way of thinking about utopia in this context. Feminist scholar Lauren Berlant (2011:1) refers to cruel optimism as being how 'something you desire is actually an obstacle to your flourishing'. While she develops this notion in relation to the rise of neoliberalism, I argue that the utopianism of Silicon Valley's imaginaries of outer space, which expresses a desire for a 'better way of living and being' through sociotechnical achievements in human spaceflight, runs the risk of being an obstacle to human flourishing on this planet.

As Latour (2015) argues, the possibility of a 'good future' depends on humans and the planet finding a way to get along. Human beings visiting Mars would be a profound undertaking, with great potential for scientific research and understanding, and a good opportunity for international cooperation. However, Musk's vision is not concerned with finding ways for humans and the Earth to find a better way to get along, and is not likely to enable that to happen. Instead, it offers what we might call a 'cruel utopia'.

Conclusion

This paper represents a new contribution to the growing field of the social studies of outer space. I have used the sociotechnical imaginaries framework to analyze how the leaders, investors and supporters of SpaceX are performing collectively shared visions of human beings as an extraplanetary species, through narratives, visualizations and technological demonstrations. This framework highlights how these visions are also animated by political and cultural claims about Earthly societies and their problems. As Jasanoff (2015: 5) argues, sociotechnical imaginaries do not simply concern specific technologies but also 'the aspirational and normative dimensions of social order'. They are therefore utopian: through them the desire 'for a better way of living and being' (Levitas 2011) finds expression.

For Silicon Valley entrepreneurs, their investment in human spaceflight is ultimately a hopeful and confident undertaking to bring about what they see as positive change in their own societies here on Earth: they would become less risk-averse, technological progress will be secured, and previously abandoned futures revived. In other words, their vision is about how 'out there' will transform things 'down here'. In this way, as McNeil et al (2016)

suggest, the framework of imaginaries emphasizes the affective dimensions of this vision. While Musk focuses on the technical achievability of his plans, his public presentations often evoke feelings of excitement, adventure, disappointment and anxiety.

Silicon Valley offers an 'extraplanetary imaginary' that yokes together commitments to technological progress, libertarian desires of human freedom, and a means to escape or evade risks and dangers that stem in the main from global capitalism. In this future, the path is led by entrepreneurial, charismatic and powerful individuals inspiring people by their visions for better worlds through technological change – rather than led by public institutions. This complements the 'Californian ideology' as characterized by Barbrook and Cameron (1996). Ironically, as with the history of Silicon Valley more generally, their efforts are underpinned by financial and political investments from the US Federal Government through high-value contracts to ensure that its military and national security agencies have continuing access to orbital space. It is also achieved by workers who are expected to submit themselves to demanding schedules and to embrace long working hours to actualize radically cheaper orbital launches and by extension the vision of becoming an 'multiplanetary species'.

Furthermore, I have drawn on other STS work to consider contestations or resistances to these 'extraplanetary imaginaries', by discussing the work of scholars in the field in relation to debates about technological innovation and planetary change. Musk's vision is situated at the nexus of two opposing futures that feed into each other: one characterized by sociotechnical optimism and the other by a planetary pessimism about global environmental change. According to critics such as Latour (2013) and Russell and Vinsel (2017), Musk and others are projecting a utopia that cannot be achieved. They dispute that innovation in outer space technologies will make the world a better place and reject the idea that wealthy billionaires should set an agenda, offering apparent solutions to the problems created by capitalism itself, from which they derive their wealth and power. The optimism of settling Mars is predicated on a pessimism that we cannot save Earth. In short, they offer 'cruel utopias': although exciting in ambition and design, they could impede the flourishing of humans and the planet in our current predicament.

We do not yet know whether the likes of SpaceX or Blue Origin will indeed succeed in their efforts to transform spaceflight. However, today we can see extremely wealthy individuals seeking to shape shared social and political imaginings of possible and preferable human futures. Therefore, as Valentine (2012: 1064) argues, critical scholarship must engage with the 'explicit utopian futures of people who are powerful enough to at least set them in motion'. I've sought to do this by focusing on Elon Musk and his company SpaceX and its

sociotechnical imaginaries of desirable and optimistic futures. In sum, my paper represents an effort to 'stay with the trouble' (Haraway 2016) of contested outer space utopias in Silicon Valley.

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