# A Pragmatist Perspective on Human Migration to Mars

by

Bradley Michael Hillas

# A Pragmatist Perspective on Human Migration to Mars

by

Bradley Michael Hillas

Master's Thesis

University of Twente

Faculty of Behavioural, Management and Social Sciences

Enschede, The Netherlands

Date: 18/11/2020

First supervisor: Dr. Yashar Saghai

Second reader: Prof. Dr. Philip Brey

MSc Philosophy of Science, Technology & Society – PSTS

# CONTENTS

# INTRODUCTION

## 1. Background

*1.1 After Apollo*

In the early 1970s, US President Richard Nixon was presented with two options: one was a type of partially reusable spacecraft, the other was sending humans to Mars. The latter had been proposed by Dr Werner von Braun – chief architect of the Saturn V rocket, which had successfully launched astronauts to the Moon six times between 1969 and 1972. As the Apollo Moon program came to an end, Nixon had to decide on what would succeed it. In the end, he passed on the Mars proposal, opting instead for the craft that would become known as the Space Shuttle (Petranek 2015).

Von Braun was not alone in having his sights set on Mars. At the height of the Apollo program, many believed that sending astronauts to the red planet would be the next step (Davenport 2018). But after the program's cancellation, NASA never again matched the peak of spending and manpower that it had achieved in the late 1960s, and the US government subsequently retreated to a more cautious approach to space (Davenport 2018). Indeed, NASA has been subject to the waxing and waning of political will over the decades since Apollo (Davenport 2018). Government plans to return humans to the Moon and to reach Mars have frequently been abandoned due to political and budgetary constraints (Zubrin 2011, 59).

Whilst the US government has retreated to a more incremental approach, there have been major upheavals in the space industry in recent decades. This has largely been due to a handful of new private companies. *SpaceX*, founded by entrepreneur Elon Musk; *Blue Origin*, owned by Amazon's creator Jeff Bezos; and Richard Branson's *Virgin Galactic* are some of the most notable and well-known examples. The visions and underlying motivations of these billionaires are by no means in alignment, but they share a common purpose in wanting to drastically lower the cost of travelling to space (Davenport 2018). SpaceX and Blue Origin have seen a great deal of success on this front, having pioneered methods which allow for rocket boosters to be re-used for subsequent flights, thus saving a huge amount of the cost for new launches (Henry 2017).

The long-term goals of SpaceX make it particularly relevant for this thesis, as exemplified by their mission statement: "The company was founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets" ("About SpaceX", 2020). The company's founder, Elon Musk, has on multiple occasions outlined his company's plans to enable humans to live

permanently on Mars (Anderson 2014). This process is commonly referred to as 'colonisation', and it has been a feature of science fiction since the 19th century (Miller 2011, 17). And now, with new technologies and new players involved, the idea has seen renewed interest.

## 2. Mars migration

*2.1 Definitions*

It is worth stating from the outset that, although authors in academic and non-academic writings tend to use terms like 'colonisation' or 'settlement', I will primarily refer to the process of moving humans permanently to Mars as 'migration'. In Chapter 3, I will elaborate on why I favour this term. Elsewhere, in sections where I discuss the arguments of specific authors, it may be appropriate to use the terms they employ.

For now, some important distinctions must be made between migrating to Mars and merely visiting. Many of the technologies and methods for sending humans for a time-limited scientific exploration mission would also be involved in a migration mission: rocketry, life support systems, and so on. But by 'migration', I am specifically referring to the establishment of semi-permanent and permanent habitats on Mars. These are intended as homes for a population which would grow in size over time due to successive new arrivals from Earth and perhaps eventually procreation by humans on the planet itself. Though they would rely on re-supplies from Earth, the population would need to be largely self-sustaining, due to the huge travel distance and the significant lag time in communication. Certain activities would therefore be essential, such as growing food on the planet and gathering vital materials from local sources (Zubrin 2011, 233 – 265)

These kinds of activities are what distinguishes a migration mission from a scientific mission, or the "flags and footprints" exercises of the Apollo missions (Milligan 2016, 33). A scientific mission on Mars would likely last up to eighteen months or more to justify the long trip and to make use of the Earth-Mars launch window that opens about every 26 months (Zubrin 2011, 12). Therefore, if the plan does not involve the establishment of liveable habitats with the intention of long-term survival on the planet, we would not call this a migration mission.

I will also distinguish migration from 'terraforming': modifying or engineering a planet to make its environment more Earth-like. Terraforming is a topic which sometimes appears in academic discussions of Mars migration, but it involves both highly speculative technology and timeframes which are thought to span centuries - even millennia (Fogg 1995). I will therefore not discuss terraforming in this thesis; instead, I will limit my discussion to what we can call the early phase of migration i.e the first few decades of establishing self-sustaining communities.

*2.2 Why Mars?*

Of the hundreds of bodies in our solar system, what makes Mars the most likely target for human migration? In many ways, the planet is hostile to life as we know it. The thin atmosphere provides little protection from the Sun's damaging ultraviolet radiation. Surface temperatures vary from −125 °C at the polar caps to 20 °C in equatorial summer (Sharp 2017), with seasons lasting twice as long as Earth's. The atmosphere is mostly carbon dioxide, and dust storms with winds of up to 160kmph can sometimes cover the entire planet (Mersmann 2015). And there is of course the formidable distance from Earth, which can vary from 55.76 million km to 401 million km, depending on the relative orbit of the two planets (Sharp 2017).

Yet, in other ways, the Earth and Mars are similar. The Martian day (a *sol*) is about the same as Earth's at just over 24 hours. The two planets have a comparable land surface area (although Mars' is contiguous, with no liquid oceans). Mars also possesses essential elements: carbon, nitrogen, hydrogen, oxygen and, crucially, water - though this is mostly locked up as ice caps or in the Martian soil (known as *regolith*) (Petranek 2015). These latter characteristics are crucial factors for missions that rely heavily on *in situ* resource utilization (ISRU), as such elements are the key to making necessities like food and rocket fuel (Zubrin 2011, 15). Thus, while it is generally agreed that Mars would be an extremely difficult place to live, it is seen as the most viable candidate.

## 3. Problem statement and research question

*3.1 Problem statement*

The notion of migrating to Mars finds sympathy in academic circles. Philosophers and non-philosophers often give similar reasons to those offered by space entrepreneurs. For some, the threat of some cosmic catastrophe is good grounds for arguing that we have a moral obligation to make humans multi-planetary, because this supposedly offers the best chance of the species continuing (Munevar 2019, 38). Others argue that humanity's survival on this planet is intrinsically linked with 'space settlement' (Cockell 2007, 2).

The other side of the debate – those against Mars migration - offer a variety of reasons for their objections. From the perspective of environmental philosophy, some argue that Mars has an intrinsic value which should not be interfered with (Marshall 1993, 227). Others point to human shortcomings, arguing that humans are not cognitively, socially or morally ready for such an undertaking and that we are likely to repeat the same mistakes on Mars as we have on Earth (Marino 2019, 15) (Billings 2019, 44).

Authors who discuss the ethics of Mars migration often do so from the perspective of traditional ethics, usually employing some form of consequentialism or deontology. Each of these perspectives can offer much insight, though there is little consensus. This brief sketch of the contours of the debate outlines the problem: how to morally justify Mars migration in such a way that addresses the most pressing concerns on both sides and moves the debate forward?

*3.2 Research question and approach*

My research question is, *"*Can human migration to Mars be morally justified?" I will approach this question from a pragmatist perspective, a philosophical tradition that originated in the United States in the late 19th Century. There are a few reasons why I am opting for this approach. Firstly, there is a notable gap in the literature. Though there are plenty of academic writings on migration to Mars, none of them takes a pragmatist point of view. Secondly, and as I will explain in this section, the traditional ethical approaches taken up by authors writing about Mars migration may not be adequate for the task of mounting a convincing justification.

Pragmatism does not represent a systematic set of beliefs per se; rather a "particular series of theses" or a "toolbox" (Zwart 2002, 37) (Keulartz et al. 2002, 12). Broadly speaking, pragmatism "understands knowing the world as inseparable from agency within it" (Legg & Hookway 2020). The core of pragmatism as originally conceived by Charles Sanders Peirce was summarised in the Pragmatic Maxim: "a rule for clarifying the meaning of hypotheses by tracing their 'practical consequences' – their implications for experience in specific situations" (Legg & Hookway 2020). The authors considered as the classical pragmatists (Charles Sanders Peirce, William James and John Dewey) articulated the perspective differently, but this Maxim indicates the empiricist attitude that characterises the approach (Legg & Hookway 2020).

Another enlightening characterisation of pragmatism is that of a series of "anti-theses" which are "aimed against particular basic philosophical principles that form obstacles to a productive solution of problems" (Keulartz et al. 2002, 14). These anti-theses are typically formulated as *anti-foundationalism* (a rejection of the Cartesian quest for certainty in favour of fallibilism and context-sensitivity); *anti-dualism* (a rejection of the dualisms of traditional philosophy as having ontological status); *anti-scepticism* (a rejection of universal doubt as untenable due to the inescapability of our prejudices) (Keulartz et al. 2002, 14). Pragmatism thus tends to define itself explicitly in contrast with traditional philosophical approaches.

In this thesis, I will draw on several key ideas from the work of John Dewey in particular. Given the dramatic changes he witnessed in his lifetime, Dewey felt that traditional ethical theories were not

adapted to "respond intelligently to new circumstances" (Anderson 2019). Rather than searching for some single fixed ethical principle, Dewey portrays ethics as a type of inquiry that is akin to scientific inquiry, one which aims to improve our value judgements "in light of the consequences of acting on them" (Anderson 2019). Dewey was also concerned with what he saw as elitism in traditional philosophy. He saw its preoccupation with finding "certainty, stability and simplicity" as a futile search that subordinated "practical service to ordinary people" (Anderson 2019). For Dewey, moral inquiry is inherently social, and he promoted democracy as the best means to foster 'intelligent moral inquiry' (Dewey 1927).

In response to my research question, I will argue that, rather than finding one definitive argument in favour of Mars migration which purports to be the most convincing, we first need to re-assess the conditions and procedures by which such an argument is formulated. This is in order to address some of the inherent injustices that characterise both the technology of Mars migration and its associated discourse. To make a morally justifiable case, we must first examine the language we use in the moral debate. In addition, if we diverge from traditional ethics to a Deweyan pragmatist ethic that is more akin to scientific inquiry - one that is fostered by democratic institutions – then we are much more likely to get better outcomes. Ultimately, I argue that Mars migration can most likely be justified, but only if these minimal conditions are met.

## 4. Thesis structure

*4.1 Chapters*

The thesis will be divided into two main parts. Part one (chapters 1 and 2) will be an overview of the technological side of Mars migration and its associated philosophical discourse. Part two (chapters 3 and 4) will consist of my original contribution i.e the pragmatist perspective on the Mars migration debate.

The first chapter will give a brief overview of some of the technologies proposed as essential for Mars migration. I will also identify which agencies and organizations plan to do this in the future, and some of their reasons and justifications.

The second chapter will explain and compare some prominent arguments for and against Mars migration. My aim here is to determine which, if any, arguments we can rule out. The premises that I find to be the most compelling in this chapter will be addressed again later in Chapter 4 with a pragmatist perspective. Using general philosophical criteria, I will determine whether such arguments generate a convincing account of the moral permissibility or impermissibility of Mars migration. Firstly,

I will analyse Gonzalo Munevar's argument that we have an obligation to 'colonise' outer space to prevent a cosmic catastrophe (Munevar 2019, 38). Secondly, I will analyse Charles S. Cockell's argument that space migration (including to Mars) will confer benefits to the Earth (Cockell 2007, 1). Key sub-questions to be addressed here are: Is Mars migration morally permissible as a way to ensure the survival of the species (by preventing cosmic catastrophes or other existential risks)? Are potential benefits for the Earth a good enough reason to justify Mars migration?

Next, I will analyse prominent arguments against migration. The first is Alan Marshall's argument that we ought to leave Mars the way it is because it has intrinsic value (Marshall 1993, 227). After this, I will consider Lori Marino's argument that humanity is not cognitively, morally or socially prepared to 'colonise' Mars (Marino 2019, 2015). The key sub-questions to be addressed here are: Is migration to Mars impermissible on the grounds that we ought to protect Mars' intrinsic value? Is migration impermissible because of the negative consequences it will have for Earth?

The third chapter will examine some key terms in the debate: 'colonisation' and 'humanity'. I will explore the conceptual and historical facets of these terms and discuss how they are used in the debate. I will also make an argument in favour of 'migration'. A key question addressed in this section: What is the significance of the 'moral vocabularies' used in the Mars migration debate? (Swierstra 2002, 223).

In the fourth chapter, I will present an argument for adopting a pragmatist perspective on Mars migration. Mainly drawing on insights from John Dewey, I will re-visit some of the key premises discussed in Chapter 2. I will also elaborate further on some tenets of Dewey's thought that can fruitfully serve the Mars migration debate. Some key sub-questions will be addressed: What approach to ethics is suitable when discussing Mars migration? What are the procedural conditions for making a convincing argument in favour of Mars migration?

In the concluding chapter, I will summarise the main findings of the thesis. I will also discuss limitations and further questions that might have arisen during the research.

*4.2 Limitations*

As mentioned, I will focus my discussion on the question of Mars migration, and not brief trips focused on scientific exploration, or more long-term efforts to terraform the planet. I do not intend to address is whether or not migration to Mars is technically feasible. This question features prominently in discussions in the media and academia, but I will focus instead on normative questions. Similarly, I will

not speculate on the economic or political feasibility of the venture – whether it can be paid for, and what kind of political negotiations might have to take place for it to happen.

I will also not comment on the transportation of non-human animals to Mars, which has been proposed by some authors. In this thesis, I will focus exclusively on human beings (Johnson 2019, 24)

Finally, I will also not discuss the kind of political or ethical system that ought to govern the usage of land on Mars or the conduct between the inhabitants of Mars.

# PART 1

## CHAPTER 1

## Migrating to Mars: How, Who and Why?

### Introduction

Several agencies and organisations have expressed an interest in migrating to Mars, and there is no shortage of proposals for how to do it. However, differing priorities and visions of what Mars represents, as well as varying estimations of time and cost, lead to many disagreements on the specifics. In this chapter, I will not provide an exhaustive list of all the proposals that have been put forward. I will outline instead some of the most popular proposals that are supported by prominent experts in the field. I will end the chapter by describing some of the reasons that space advocates have given for migrating to Mars.

### 1. The Technology of Mars Migration

Mars migration would necessarily involve a complex array of different technologies specially designed for purpose (Petranek 2015). The bare minimum needed for migration may include habitats, basic utilities (power, oxygen, communications, sanitation and waste disposal, and water recycling), local and off-planet communication equipment, shop workspaces, resource extraction equipment, food production spaces and equipment, propellant production equipment, bodysuits, rovers, 3D printers and more (Zubrin 2011). Petranek boils this down to five survival needs: water, oxygen, food, shelter and clothing (Petranek 2015) I will provide a brief sketch of some of the suggested ways to secure these essentials.

*1.1 Water*

Water is the key element for humans to survive long-term on Mars (Petranek 2015) (Zubrin 2011, 201). By current estimates, the planet might hold as much as two million cubic kilometres of water ice – much of it at the Northern and Southern poles (Zubrin 2011, 202). As well as needing it for drinking, Mars astronauts can use electrolysis to create oxygen and rocket fuel (Petranek 2015); for producing building materials like plastics, bricks and mortar, and for growing food (Zubrin 2011, 201).

Due to weight, it is unlikely water would be transported to the planet, though in the early missions humans could transport hydrogen to the planet to combine it with the oxygen in Mars' carbon dioxide atmosphere (Zubrin 2011, 201). As Zubrin says, however, ever-expanding human activity on Mars will

place greater water demands on the planet, and so obtaining it from the planet itself is crucial (Zubrin 2011, 202).

*1.2 Oxygen*

Humans need oxygen, but the atmosphere on Mars is 95.32% carbon dioxide, with 2.6% nitrogen, 1.9% argon, and only trace amounts of carbon monoxide, oxygen, hydrogen and water vapour (Franz et al. 2017). Given the molecular makeup of carbon dioxide, however, this means that at least 70% of the atmosphere on Mars is, by mass, oxygen (Petranek 2015). Water's mass is even higher in oxygen (about 89%) and, as mentioned, astronauts can use electrolysis to separate water molecules to release oxygen and hydrogen (Petranek 2015). NASA's *Perseverance* rover – launched in July 2020 - includes a fuel cell for converting atmospheric C02 into oxygen and carbon monoxide. This experiment is there as preparation for a future human mission ("What is surface operations?", n.d).

*1.3 Food*

Enough is known about Martian regolith for scientists to argue that it could make good soil (Petranek 2015) (Wamelink, Frissel, Krijnen, Verwoert, & Goedhart 2014). Food grown on Mars must be high in nutrition while taking up a small amount of space (Petranek 2015). A popular proposition is the use of inflatable, pressurized greenhouses – preferably near the equator for maximum sunlight (Zubrin 2011, 211) (Petranek 2015). Though the levels of sunlight required for photosynthesis on Mars are around 43% those of Earth, this has been suggested as adequate (Zubrin 2011, 211). Moreover, the ready availability of Co2 on Mars could accelerate photosynthesis by filling greenhouse domes with higher concentrations of the gas (Zubrin 2011, 211). Other propositions include the use of underground hydroponics – growing crops in nutrient-rich water without soil – which will protect crops from radiation and allow for tight control of the environment (Petranek 2015). Despite these proposals, it is doubtful that 100% of what Mars astronauts eat will be grown – supplies would likely come from Earth for a long time (Petranek 2015).

*1.4 Shelter*

For habitable structures, Zubrin again proposes an ISRU approach - that is, building new livable structures from locally-sourced materials (Zubrin 2011, 189). His low-tech solution involves making bricks from Martian regolith (Zubrin 2011, 190). These could be used to make pressurized structures either singly or in a series with a Roman-style vault, covered with soil to create a downward compression load. The dirt layer has the additional benefit of providing radiation shielding and thermal insulation (Zubrin 2011, 191).

Many researchers are confident that other materials suitable for shelter building could be produced on Mars, including plastics, iron and perhaps steel and copper (Petranek 2015). Before more long-

term habitats can be built, however, early arrivals would likely have to rely on caves, fissures and lava tubes for protection from radiation (Petranek 2015).

### 1.5 Clothing

Suits are essential for humans to survive on Mars due to the cold, the lack of oxygen and the lack of atmospheric pressure (Petranek 2015). Whilst some advocate for traditional gas-pressurized suits, other researchers are working on more elastic, wearable and non-pressurized "bio suits" (Chu 2014). Dava Newman of MIT proposes reducing the bulk with the bare minimum of radiation shielding since astronauts will spend most of their time in a habitat or rover vehicle (Petranek 2015).

## 2. Who Plans to Migrate to Mars?

### 2.1 NASA

Despite its scaling back of ambitions since Apollo, NASA does have plans to travel to Mars and to move humans there permanently. NASA outlines three thresholds on the way to this goal: "Earth reliant", "proving ground" and "Earth independent" ("Journey to Mars" 2018). The 'Earth reliant' phase focusses on testing technologies and advancing human health and performance research on the ISS, in preparation for long-duration missions. The 'proving ground' involves conducting complex operations around the Moon, to prepare humans for operations far from Earth and to "advance and validate capabilities required for human exploration of Mars" ("Journey to Mars" 2018). Finally, the 'Earth independent' phase is where missions to Mars orbit, to Martian moons and eventually the Martian surface take place, with plans to stay long-term ("Journey to Mars" 2018).

To achieve these goals, NASA has been seeking support from the partners of the ISS, in accordance with the Global Exploration Roadmap - a collaborative effort of 14 space agencies around the world that aims to "expand human presence into the Solar System, with the surface of Mars as a common driving goal" (Laurini, K., Piedboeuf, J. C., Schade, B., Matsumoto, K., Spiero, F., & Lorenzoni, A. 2018, para. 1). The list of space agencies in this list demonstrates how many governments around the world have expressed an interest in space exploration in general, and Mars in particular – though not all of them have explicitly laid out plans for Mars migration.

### 2.2 Other Space Agencies

The China National Space Administration announced in 2006 that it would initiate deep space exploration with a focus on Mars, and it expects crewed missions in the period between 2040 and 2060 (Peoples Daily Online 2006). From 2007 to 2011, and in cooperation with Russia and the European space agency, a long-term psychological isolation experiment called Mars 500 was conducted to prepare for this mission (Amos 2011). It holds the world record for the longest high-fidelity spaceflight simulation ("Welcome back and thank you, Mars500" 2011).

The United Arb Emirates announced in 2017 that they plan to build a human base on Mars within the next hundred years (Griggs 2017). In the same year, they launched the Mars Science City project, with the plan being to build a prototype city on Earth which will simulate many of the conditions in a Mars habitat (Feltman 2017).

*2.3 SpaceX*

As noted in the introductory chapter, SpaceX is worth discussing in more detail because of its long-term goal of making the human species interplanetary. Unlike other space-based start-ups which failed, SpaceX has had many successes since its founding in 2002. As of April 3rd 2020, the company has a total of 91 successful flights on its record – most of these with the Falcon 9. Of those flights, the company has returned the rocket's booster to Earth safely intact 58 times (Sheetz 2020). Its success with re-usable rocket technology has made it one of the world's most sought-after organisations for space launches (Davenport 2018). In reducing the cost of space travel with reusable technology, the company plans to build enough capital to eventually build ships capable of transporting humans to Mars and establish bases there (Vance 2015).

A crucial step was reached by the company in May 2020 when, in partnership with NASA, SpaceX successfully flew two astronauts to the ISS (Amos 2017). More long-term plans for travel into deep space and onwards to Mars are dependent on the development of *Starship,* their heavy-lift launch vehicle which is intended for long-duration cargo and passenger-carrying missions to "the Moon, Mars and beyond" ("Starship" 2020).

*2.4 Public-Private Partnerships*

Whilst SpaceX has been disruptive in an industry which has typically been dominated by governments, they hold contracts with several public bodies. Notably, since 2006 it has held billions of dollars' worth of contracts with NASA for developing cargo and crew transports to the ISS (Stone, Lindenmoyer, French, Musk, Gump, Kathuria & Pickens 2008, 192)

NASA has relied on private companies since the beginning of the Space Age. In recent years, however, they have changed how they approach this partnership. Companies like SpaceX and Boeing are provided with a substantial portion of R&D funding by the agency, but the companies are free to build their own rockets and spacecraft (Kluger 2019).

So, whilst the success of private companies like SpaceX have had a significant impact on the space industry, public-private partnerships have been a mainstay of space exploration for decades. I mention this because the distinction between government agencies and private companies may have a bearing on how we morally delegate and allocate responsibility.

## 3. Reasons and Justifications

On many occasions, Elon Musk has outlined SpaceX's plan for Mars. He envisions a self-sustaining 'colony' of at least a million people by the end of the century, and this he sees as the only way that humans will protect themselves from being wiped out by an extinction event (Stockton 2016).

Musk has often framed the need to get off-planet as an obligation: "I think we have a duty to maintain the light of consciousness, to make sure it continues into the future" (Anderson 2014). Other billionaire entrepreneurs involved in the space industry echo similar sentiments. Jeff Bezos' visions for space are not as specific to Mars as SpaceX; he does, however, have similar concerns about the future of humanity. He has considered the possibility of an asteroid impact causing an extinction event, and suggested finding other places to live in the Solar System as a necessary hedge against such an outcome (Davenport 2018). For prominent Mars advocate, Robert Zubrin, the positive benefits to humanity are the key driver: to satisfy scientific curiosity; as inspiration for students to enter STEM subjects, and to reaffirm a pioneering spirit (Zubrin 2011, 6).

NASA does not only focus on extinction events, but that does form one part of their stated motivations for space exploration in general:

> We pioneer space to discover life, identify resources, foster economic growth, inspire and educate, protect ourselves from space-based threats, and leave a better future for the next generation (United States. National Aeronautics and Space Administration 2015, 3).

Borrowing the language from their earlier successes with Apollo, they call Mars the "next giant leap" (United States. National Aeronautics and Space Administration 2015, 3).

## 4. Chapter conclusion

In this chapter, I have described some of the technical challenges for a Mars migration mission and identified some of the key players involved in research and development. Of the justifications I have described, it is clear that they trade on certain themes. Certainly, there are other reasons put forward than those I've descri here, and not everyone who advocates for space exploration in general necessarily agrees on those reasons, nor that Mars migration is the optimal way to fulfil them. It is also difficult to know whether these are the genuine underlying motivations of those spearheading the efforts to migrate to Mars. Nevertheless, these kinds of arguments have a lot of currency both with academics and non-academics. In the next chapter, I will analyse how the question of Mars migration is treated in the philosophical literature.

# CHAPTER 2

# Evaluating Arguments For and Against Mars Migration

**Introduction**

In this chapter, I will evaluate a few arguments regarding Mars migration: two in favour and two against. This chapter is not intended to give an exhaustive overview of all the perspectives in the Mars migration debate. I have chosen these arguments because they are somewhat representative of certain themes which regularly appear in the academic and non-academic discourse. For example, I have classed the first argument as a "Survival of Humanity" argument. It is important to note that, while many authors – as well as non-academic migration advocates – endorse this kind of argument (Stoner 2017, 339), they do not all focus on the same threats to human survival, nor do they draw on the same ethical approach in mounting their arguments or derive the same ramifications. So while the evaluation I provide for one specific 'Survival of Humanity' argument raises points that may also apply to other authors arguing in a similar vein, it does not cover all possible points against every argument under that banner. For this thesis, that is not strictly necessary.

I readily admit arguments put forward by non-philosophers, such as Lori Marino, not least because many of the points she raises can and have been put in service of philosophically based arguments for and against migration. And, as has been mentioned, the arguments put forward by individuals in the space industry plays an important role throughout this thesis.

In terms of evaluation, I will discuss these in terms of their persuasiveness, internal consistency and by how well they accord with our moral intuitions. In determining which elements are persuasive, I hope to draw on them when mounting a pragmatic case in favour of migrating to Mars.

## Arguments in Favour

### 1. Survival of Humanity

Fears that Earth could be devastated by some natural or human-made global catastrophe are prominent in the Mars migration debate. By seeding another planet with a self-sustaining population, the argument goes, we could reduce the likelihood that all of humanity will be wiped out (Musk 2017, 46). Variations on this kind of argument are endorsed by a range of high-profile scientists and public figures (Sagan 1994, 377) (Davies 2004) (Highfield 2006).

Global catastrophes, or 'existential risks' – events that could destroy humanity entirely or prevent any chance of it recovering (Bostrom 2011, 3) – may include anthropogenic risks from technology, war or resource crises. Natural or non-anthropogenic events may include asteroid impact, cosmic threats, extraterrestrial invasion, global pandemic, natural climate change or volcanism. These events are not thought to be equiprobable - some are highly speculative, whereas others are known to have occurred in Earth's past, as evidenced by the fossil record.

The most recent extinction event in Earth's history - approximately 66 million years ago – is widely thought to have been caused by an asteroid impact (Schulte, Alegret, Arenillas, Arz, Barton, Bown & Collins 2010, 1214). This kind of existential threat figures prominently in the Mars debate, and a number of authors see it as credible enough of a threat to argue for Mars migration as a hedge against mass extinction (Gottlieb 2019) (Munevar 2019).

For Munevar, this threat of asteroid collisions and "other cosmic catastrophes" places an obligation on humanity to migrate both to Mars and the Moon (Munevar 2019, 38). Not only would this allow humanity to survive the cataclysm, but we would also benefit from clean energy by moving polluting industries into space, and from a new ability to utilise the resources of the Solar System. In addition, and unlike many other authors who also take seriously asteroid-collision arguments in particular, Munevar emphasises that a Solar System with a heavy human presence would allow more opportunities to interfere with the trajectory of an incoming asteroid by deflecting it – either with the deliberate collision of a smaller asteroid or with nuclear explosions, for example (Munevar 2019, 39).

## 2. Evaluation

As an argument in favour of Mars migration, I would argue that 'Survival of Humanity' arguments do have some merit, particularly when we consider existential threats that might be localised to Earth. However, there are some ambiguities and issues with the argument, which I will discuss in this section.

*2.1 Discharging the obligation*

By framing Mars migration as a moral obligation, we can ask when that obligation can be said to have been discharged? In the very early phases of a migration mission, the number of personnel is likely to be small; it might be the case that a threshold number of inhabitants must be reached before we can say with satisfaction that the obligation has been fulfilled. In biology, this is known as minimal viable population (MVP),  which the "ecological threshold that specifies the smallest number of individuals in a species or population capable of persisting at a specific statistical probability level for a predetermined amount of time" (Robinson & Vath 2015). Speaking in terms of the population reproducing, this number may be as low as 50 if the intention is to prevent inbreeding (Robinson & Vath 2015). This is far lower than the millions proposed by Elon Musk (Andersen 2014). Philosophers

who endorse survival of humanity arguments do not provide a threshold number, and any who do are likely to court controversy.

A further issue related to the discharging of the obligation concerns the concept of saving 'humanity' and what exactly the term entails. I will discuss this issue in more depth in Chapter 3.

## 2.2 Range of threats

Munevar considers asteroid impacts alongside other threats from space as the reason why we are obliged to 'colonise' Mars. Whilst not responding directly to Munevar but "species-survival arguments" in general, Ian Stoner says that "the range of species-level threats addressed by a Mars colony is relatively narrow" – though he does admit that it would protect against Earth-specific threats like an asteroid strike (Stoner 2017, 339 – 340). Humanity would not be protected from threats to the entire Solar System, such as supernovae or the early expansion of the sun. He argues that the cheaper and more effective solution is to "invest in detection and redirect capabilities for near-Earth objects" and "in seed arks and hardened knowledge repositories and energy sources" (Stoner 2017, 340). According to Stoner, this trumps any moral requirements to migrate to Mars (Stoner 2017, 340).

This is an important objection. I would agree that some portion of humanity may be able to save itself from an Earth-bound asteroid, but Stoner is right to point out that the effects of other cosmic catastrophes may not be mitigated by a human presence on Mars (Stoner 2017). But do we, therefore, have a stronger obligation to pursue more catch-all technologies that could protect the human species from a wider range of threats? Or invest in a planetary-based defence system like that proposed by Stoner? In a situation where we might be forced to choose amongst competing technologies that claim to ensure the long-term survival of humanity, how do we decide?

## 2.3 Urgency

Munevar does not specify timescales. It is not clear if we should attempt to migrate to Mars as soon as possible or at some later date – perhaps when certain existential threats have become more imminent. This seems very difficult to gauge, especially since the list of possible threats range from the highly speculative (alien invasion) to more evidence-based (asteroid collision). Such diversity in types of threats, as well as their varying degrees of plausibility, make it unclear about when we should be pursuing Mars migration and thus how much energy and resources we should be contributing to the enterprise.

## 2.4 Allocation of Responsibilities

A further issue is the ambiguity of the allocation of responsibilities. Who exactly does this obligation apply to? Munevar begins his article by stating that "We have a moral obligation to colonize outer

space" (Munevar 2019, 38 – 40). Who is "we"? I mentioned in the introduction the public-private distinction can play into the moral question, and here it has a bearing on how the moral obligation is parsed out. Does the obligation apply more to private companies or governments? A case could be made that world governments have obligations towards their citizens to ensure their safety and survival and that therefore the obligation falls on them more than private companies to deploy technologies with potentially humanity-saving potential. But should this then be an intergovernmental operation, or will one national government suffice? And does the obligation apply at the institutional level – government agencies – or the individual level – presidents and prime ministers, or government-employed scientists with relevant expertise? And even if we say that governments ought to fulfil the obligation, do the private companies they are partnered with then have a secondary obligation to comply?

It is absurd to interpret Munevar's "we" as meaning that *everyone* must act to save humanity; for one thing, we would then have no grounds for pressing the obligation on space technologists and world leaders more so than anyone else. Munevar is almost certainly not suggesting this. But we can reasonably ask if the obligation requires, for example, cooperation amongst different groups. As mentioned in the introduction, Mars migration would involve an array of different technologies, and many of these might come from companies and institutions not strictly classed as space technology companies. So who ought to get involved to fulfil the obligation? It may help to distinguish between perfect and imperfect duties when addressing this question. In Immanuel Kant's formulation, perfect duties are those that must be performed whatever the circumstances; imperfect duties, on the other hand, may have to give way to more stringent ones (Blackburn 2005, 107). The case of Mars migration may make more sense as an imperfect duty, applicable in a particular time and place, and certainly not applicable to everyone.

### 2.5 Reducing the obligation's force

This potential conflict points to a common problem with duty-based morality, in how to decide in a conflict between duties. One way of dealing with this may be to reduce their categorical force by referring only to *prima facie* duties (Ross & Ross 2002) (Larry & Moore 2016). By conceiving of them this way, conflict between duties in unproblematic "so long as it does not infect what one is categorically obligated to do" (Larry & Moore 2016). As Larry and Moore note, however, such a view is "in danger of collapsing into a kind of consequentialism" (2016). In the case of competing technologies, I would argue that reducing their categorical force is the best option. For such speculative technologies and futures, the authors may be taking too much for granted in terms of what is *required by morality*.

It might be argued that - if not a duty to carry out this particular act - we at least have general obligations of beneficence and non-maleficence. As Beauchamp and Childress point out, however, it is difficult to identify specific obligations from these principles (Beauchamp & Childress 2013, 153). Those special groups with access to powerful technologies may have further special obligations to find ways to prevent harm to the human species; this may be through the establishment of a human presence on Mars or some other technology.

According to Beauchamp and Childress, "Principles of beneficence are not sufficiently broad or foundational, in our account, that they determine or justify all other principles" (Beauchamp & Childress 2013, 153). They specify some prima facie rules that come from a principle of positive beneficence, including "Prevent harm from occurring to others"; "Remove conditions that will cause harm to others"; and "Rescue persons in danger" (Beauchamp & Childress 2013, 204). We might frame Mars migration as following the second and third rules since the aim is to prevent certain harms - such as the effects of a devastating asteroid collision. However, Survival of humanity arguments are generally premised on the idea that those people established on Mars constitute the portion of humanity to be saved - those on Earth are more or less abandoned to their fate. We are then left with the question of who exactly gets to avoid harm by migrating to Mars.

As mentioned, the risks invoked by 'survival of humanity' proponents are many and varied. We might therefore frame arguments like Munevar's as a duty of rescue. In their discussion of duties of rescue, Beachamp and Childress list conditions that, if they obtain, would place an obligation of beneficence on person X:

> 1. Y is at risk of significant loss of or damage to life, health, or some other
> basic interest.
> 2. X's action is necessary (singly or in concert with others) to prevent this
> loss or damage.
> 3. X's action (singly or in concert with others) will probably prevent this
> loss or damage.
> 4. X's action would not present significant risks, costs, or burdens to X.
> 5. The benefit that Y can be expected to gain outweighs any harms, costs,
> or burdens that X is likely to incur (Beauchamp & Childress 2013, 207).

If we think of Y as 'humanity' and X as any sufficiently competent space technology organisation (company or government department), and imagine that the risk under discussion is any one of the existential threats I have mentioned, then the case for an obligation begins to unravel. Condition 1 is

uncertain, since any given existential risk will have a great deal of improbability attached to it, and the effects are often difficult to estimate. Condition 2 is difficult to assert; it would be highly unlikely that there is a consensus on the necessity of migrating to Mars to prevent loss; condition 3 is similarly dubious since the efficacy of a human presence on Mars would also be subject to doubt.

Condition 4 is certainly up for dispute since travelling to and living on Mars exposes astronauts to significant health risks, such as radiation exposure, psychological effects of isolation and confinement, the distance from Earth, the physiological impact of changing gravity fields and heightened stress levels (Brabaw 2019). I will not discuss the normative implications of health risks to astronauts at length in this thesis because, in the academic literature, the presence of such risks do not seem to warrant an outright argument against migration to Mars. The presence of such risks, however, may serve to undermine any argument from obligation in favour.

Finally, condition 5 is also uncertain since it is not even clear what Y is in this case (i.e what 'humanity' constitutes exactly). I will discuss this issue in more depth in the next chapter.

Notice that my commentary only holds in so far as none of the aforementioned existential risks is imminent; we might reassess those conditions at a point where an existential threat was much more likely to occur (such as if an asteroid was confirmed beyond doubt to be on a collision course with Earth).

All told, such ambiguities serve to reduce the categorical force of the duty to migrate to Mars, without necessarily impacting on its being morally praiseworthy. At most, then, we can say migrating to Mars to save humanity is a supererogatory act: it is morally praiseworthy without being morally obligatory.

## 3. Settling Mars to Save the Earth

A common objection to space exploration typically says that it is a waste of time and money, given that there are so many problems to solve on Earth first (Cockell 2007, Preface viii). Charles Cockell argues, however, that rather than being in opposition, environmentalism and what he calls 'space settlement' are not only compatible but "positively beneficial to each other" (Cockell 2007, Preface viii). The two groups share the same goal of "creating sustainable human communities in the cosmos" (Cockell 2007, Preface viii). Cockell's defence of space exploration certainly includes migration to Mars but also extends to a wider range of space-based activities, such as the use of satellites, probes, and the mining of asteroids for resources (Cockell 2007). For Cockell, exploring and moving into space will offer answers to fundamental scientific questions, teach us how better to protect the Earth from cosmic threats, as well as allow us to tap into space's unlimited resources (Cockell 2007, 3).

Between environmentalism and space exploration, Cockell argues for interdisciplinary connections (Cockell 2007, 8). He observes that technologies needed for the Martian environment are the same technologies that must be optimised for greater sustainability on Earth; he gives the examples of solar panels and greenhouses, both of which are necessary for sustainable living on Earth and Mars (Cockell 2007, 8). Both disciplines would improve the other, and "their amalgamation would accelerate the improving conditions of humanity faster than each discipline acting separately." (Cockell 2007, 8).

In addition, for the places on Earth commonly used as analogues of Mars or other space environments, such as Antarctica, Cockell argues that space research carried out there is giving us new reasons to protect them from "environmental impoverishment" (Cockell 2007, 15). We protect such regions, says Cockell, because they "can help us to understand others that we might one day visit" (Cockell 2007, 21).

## 3.1 Evaluation

As mentioned, Cockell's argument does not advocate for Mars migration alone, but rather space exploration and 'settlement' in general. In my evaluation, I will mainly focus on the parts of the argument that pertain to Mars migration and how it is said to benefit the Earth.

### 3.2 Benefits to the Earth

The emphasis on benefits to the Earth is one of the most appealing aspects of Cockell's argument. Unlike, for example, 'Survival of Humanity' type arguments which, as I have explained, rely on many ambiguities and must overcome practical obstacles in order to be realised, the argument put forward by Cockell can claim to help a far greater amount of people and in a more direct way. As discussed previously, it is not at all clear who the millions of inhabitants that Musk envisions on Mars would be, how they would be chosen, and what kind of lives they would live. The 'humanity' that would benefit from Cockell's vision can not only claim to be all-encompassing but would likely see the fruits of space exploration much sooner, and in a much more tangible way. The timeliness of Cockell's argument is thus crucial; with the 21$^{st}$ century representing a crucial moment in Earth's history due to anthropogenic climate change, any argument that seeks to save humanity on Earth is likely to have greater cache than one which purports to save a poorly-defined 'humanity' in the future.

### 3.3 Technology on Earth vs technology on Mars

Cockell observes that many of the technologies that would allow for more sustainable living on Earth also need to be perfected for a Mars 'settlement' mission (Cockell 2007, 2). This is an important point, and it speaks to one of the ways that migration to Mars may have more relevance for our terrestrial concerns than is sometimes thought. However, Cockell might be assuming too much about the economic forces behind the adoption of such technologies.

He gives the example of solar panels, and how different engineers developing them to operate on Earth or Mars might target similar problems: how to work efficiently even if dusty and cloudy conditions (Cockell 2007, 7). However, even if some of the technical challenges are similar, solar panels would be deployed on Mars in a vastly different context than on Earth. The adoption of solar technology on Earth takes place in a complex societal context, where consumer choices, corporate interests, government policy and a myriad of other factors intersect. And whilst I am not arguing that a Mars migration mission would be insulated from such forces, it may be that Cockell is somewhat downplaying the difficulty of wider adoption of such technology and assuming that the main obstacle is technical efficiency. If his argument hinges on the environmental benefits to Earth, there is much more to say about the political and societal obstacles that exist on this planet.

*3.4 How strong an argument is this for Mars migration per se?*

Despite the appeals of the argument I outlined in section 3.2, it could be objected that Cockell's argument does not make a strong enough case for Mars migration. Even if the development of technologies required for Mars migration might aid and accelerate developments in environmentalism, we might question whether some other non-space-based development might do that job just as well, or better. Or, given the variety of possible technological ventures into space, it is not clear that Mars migration would necessarily be evaluated as being the one most likely to bring about the most benefits to Earth; it might be that constructing a habitat in orbit around the Earth would be better, such as an O'Neill cylinder (O'Neill 1977). For Mars migration to be justified from a moral point of view, we might demand a more robust argument in favour of Mars migration for itself i.e for the benefits and knowledge we will gain from it that do not necessarily aid the environmentalist's cause but which are valuable in themselves.

Finally, it might be questioned whether it even makes sense to put so much effort into Mars migration for the benefits it would confer on Earth when, instead of putting time and resources into space exploration, we could double our efforts for environmentalism alone. I will revisit an argument similar to this one in Chapter 3.

# Arguments Against

## 4. The Intrinsic Value of Mars

In Marshall's paper, he uses Mars as a test case "from which an ethical argument emerges for the protection of environments beyond Earth" (Marshall 1993, 228). Such an argument would recognise "the intrinsic value of all living species and natural environments" (Marshall 1993, 227). He warns

against the instrumentalist Conservation ethic that currently governs the protection of extra-terrestrial environments in order to maintain our high standard of living (Marshall 1993, 227 – 229).

Of the concern that does exist for extra-terrestrial environments, it is mainly focused on so-called forward contamination – the contamination of bodies in the Solar System by organisms from Earth – which can interfere with life-detection experiments (Marshall 1993, 231). Guidelines to mitigate against this have been in place since 1959, though they have not always been adhered to in practice (Marshall 1993, 231). Whilst the scientific question of whether life exists in Mars is not yet answered (McKay 1997), Marshall states that, if it does exist it "may be intensely susceptible to invasion by humanity and its pollutants" (Marshall 1993, 231). Forward contamination may kill indigenous microbes or alter the environment so that it kills them (Marshall 1993, 231).

Even though the possibility of life on Mars is debatable, we should be cautious and explore Mars with "sterilised unmanned probes extensively before embarking on a series of manned missions" (Marshall 1993, 232). If we do discover life, a human mission would be "out of the question" (Marshall 1993, 233). This threat of contamination therefore does not bode well for a migration mission. As Marshall says, "With permanent bases, contamination of Mars would be assured", and exacerbated by an increase in the size of such bases and any resource extraction activities (Marshall 1993, 232).

## 4.1 Evaluation

Many popular proposals for Mars migration heavily emphasise resource extraction and ever-increasing territorial settlement (Zubrin 2011). Marshall's argument would seriously curtail this kind of activity due to the risk of contamination. I agree with Marshall that this possibility should be taken seriously; however, other aspects of his argument are harder to defend.

### 4.2 The Search for Life

Marshall admits of one major difficulty himself: judging how much searching should be done before we can determine that Mars is devoid of life (Marshall 1993, 233). In the case of Mars, it could be decades or more before scientists could assert this with satisfaction. These difficulties are compounded if we take seriously Marshall's overarching aim of protecting "environments beyond Earth" (Marshall 1993, 228). Even within our Solar System, this encompasses a large number of places, including 13 planets and dwarf planets and 181 known moons. As explained in Chapter One, Mars is at the more promising end of the scale of places which could harbour life, but there are others, such as Jupiter's moon Europa (Chyba 2000). And the candidacy for potentially life-bearing planets is based on life science *as we know it*. Many scientists are open to us discovering life in places previously supposed to be uninhabitable (Wall 2019). Given the difficulty of declaring when life is decidedly not present on Mars, those problems multiply when applied to the whole Solar System.

Furthermore, life is not necessarily the only obstacle. Marshall says that "If Mars, or any other planetary body, is devoid of life it does not follow that it is devoid of value beyond any resources it may have that are useful to humans" (Marshall 1993, 234). I would agree with Marshall on this point, and a Conservation ethic which viewed environments beyond Earth as mere resources might sow the seeds for new environmental crises beyond Earth, as he says (Marshall 1993, 227). However, there remains much ambiguity about how the valuing of these environments is done, and such restrictions multiply as we apply them to more environments beyond Earth. In other words, taking Marshall's argument seriously and applying it to the whole Solar System may leave humanity confined to Earth indefinitely.

### 4.3 Intrinsic value

What is the status of intrinsic value? In philosophy, it is meant that something has value "in itself", or "in its own right" (Zimmerman and Bradley 2019). For Marshall, such value is "not imposed by human beings" – rather, it merely involves the "human recognition of value" (Marshall 1993, 233). But I would argue that this understanding is not reflected in Marshall's usage of the concept.

Marshall implies a hierarchy of value. Martian life, he says, would be intrinsically valuable and would preclude a manned mission outright due to the risk of contamination (Marshall 1993, 233). He is more permissive of a manned mission if it were proved that life on Mars did not exist but, even so, he still asserts the intrinsic value of the non-living Martian environment (Marshall 1993, 233). Mars "possesses its own uniqueness and diversity" which we should respect, even if it has not produced life (Marshall 1993, 234). In terms of human activity on the planet, he says that a significant portion of the physical environment should be preserved even if the planet is determined to be devoid of life (Marshall 1993, 234 – 235). So, by Marshall's reckoning, both living and non-living things on Mars are intrinsically valuable, but living things are more valuable than non-living. If, however, intrinsic value is "not imposed by human beings" (Marshall 1993, 233), then by what power can this hierarchy be asserted? What would inform the decision as to which parts of Mars could be used for human activity, and which should be cordoned off? One response to this may be that intrinsic value can still permit things as more or less valuable. If that is the case, it is not clear how Marshall can still maintain that making this determination is not imposed by humans, especially when he allows that the differences in value serve as a guide to behaviour i.e in humans' designating certain areas as deserving of complete protection and others not. Thus, while Marshall claims that intrinsic value is not a human value, there is implicit anthropocentrism to his argument.

One possible justification as to why the intrinsic value of life is more valuable than the non-living is due to its rarity in the universe. Arguably, however, such an argument might lose its power when

applied to environments beyond Earth. If Martian life were discovered and if it could be proved that it had an independent genesis from life on Earth, then life in the universe is evidently not as rare as we thought. Indeed, if life can have two independent geneses within the same star system then we would know that life is common in the universe (McKay 2011, 595). This is not say that Martian life should not be protected, only that an argument of intrinsic value based on rarity loses some of its power if it turns out that life is not all that rare.

Finally, it is not clear what intrinsic value instructs us to do – on Earth or beyond. Like many authors, Marshall makes the general argument that we should deal with Earth's problems first (Marshall 1993, 234). However, whereas some might say that we need to learn how to live on Earth sustainably, others, like Munevar, might argue that we should ease the pressure on the Earth's natural environments by moving people and industries beyond Earth (Munevar 2019, 38). As Marshall himself says, "In the end, the decision about what is an acceptable environmental policy for extra-terrestrial situations and what is not is not likely to be the same for everyone" (Marshall 1993, 235). The import of this cannot be overstated; it speaks to the difficulty of the conflict of values that are regularly apparent when discussing Mars migration and why a democratic approach is more favourable (see Chapter 4).

## 5. Humanity is Not Prepared

Lori Marino's argument against Mars migration is in keeping with a common theme of objections: any human presence on Mars will replicate the problems we have on Earth. Marino argues that this is due to our species' "psychological and cognitive limitations" (Marino 2019, 15). Notions of the human species being sustained by a human presence on Mars, she says, are "based on false premises" (Marino 2019, 15).

In support of her point, Marino marshals a host of unsettling facts about humanity's track record on Earth. She cites human population growth and its impact on the number of species around the planet; the strain humans are putting on the Earth's resources, which causes political instability, economic inequality, lack of access to food and water and an increase in violent conflict (Marino 2019, 16). Mismanagement manifests as global warming, deforestation, intensive animal agriculture, over-fishing, and consumer waste products polluting the environment. The conclusion from all this is that we are unqualified to 'colonise' another planet (Marino 2019, 17).

Marino outlines the kind of replies typically given by Mars advocates, which all amount to a claim that we will improve on our mistakes and not make the same ones again. She reads this as meaning that "the earth and its inhabitants are disposable and we can start all over again" (Marino 2019, 17).

Marino argues that the human brain – with all of its cognitive biases and limitations that cause these problems on Earth – will be the same as that which migrates to Mars, and it is fatal hubris to think that we can live sustainably there when we have not even been able to manage it here (Marino 2019, 17). As she says, "there is no evidence that we can change who we are that dramatically" (Marino 2019, 17).

## 5.1 Evaluation

### 5.2 Human impact and hubris

There is little disputing Marino's evidence of humankind's impact on the planet, though some do try. Despite the best efforts of so-called 'climate sceptics' who have gone to great lengths to discredit the idea, the majority scientific consensus is that there is a definite link between human activity and climate change (Anderegg, Prall, Harold & Schneider 2010). Indeed, the human species' impact on the planet has been so great that some geologists have proposed designating the current epoch as the 'Anthropocene' (Crutzen 2006). I would also agree that there is scant evidence that humans would "do better next time" (Marino 2019, 17), and it is a heavy burden of proof on anyone making such a claim.

Also, it seems intuitively correct to say that is it hubris to think that Mars would entail 'starting over', free of all the problems that we have created on Earth – especially given that any humans on Mars would likely be reliant on Earth for a long time (Petranek 2015). The charge of hubris lands even harder when we consider some of the most prominent personalities spearheading space exploration, such as Elon Musk, who is prone to high-profile technological stunts and has a record of drastically overestimating his own company's ability to overcome huge technical challenges whilst underestimating the time needed to do so (Davenport 2018).

### 5.3 Biological vs historical explanations

Despite the truth of many of her claims, Marino's explanation is spurious. She pinpoints human psychology and cognitive biases as the deciding factors – the reason we will replicate Earth problems on Mars (Marino 2019, 15). Firstly, she does not detail exactly which cognitive biases or what aspects of our psychology lead to certain behaviours - presumably, she is talking about traits common to all of humanity. What then does this imply? Does it mean that humanity is doomed by its very nature to destroy any environment in which it finds itself? Are our destructive capacities programmed into our biological makeup or the product of contingent environmental circumstance?

Such questions belong to the nature vs nurture debate, and as such, there is a huge amount of literature that attempts to address these kinds of questions. Supporters of the environmental explanation might emphasise the social, economic and political systems which have fostered and

created the problems listed by Marino, and therefore argue that we always have the option to change for the better. Indeed, her argument can be read more as a critique of late capitalism than innate human predispositions. One might respond that, even if that were the true causal explanation, Mars migration efforts are a product of the same capitalist system, and so the flaws and excesses of that system will simply be transported to Mars.

*5.4 Disposable planet*

Marino's accusation that Mars migration advocates have a "disposable planet" mentality may be ungenerous (Marino 2019, 15). However, even if the accusation highlights a truth, it is not certain that such a mentality would manifest itself as a negative consequence for Earth. As has been mentioned, a Mars migration mission would likely involve only a few hundred inhabitants in its early years; even if it were to reach tens of thousands (as envisioned by Musk)(2017), this would still mean that the vast majority of the human population lived on Earth. Marino's assumption here may be that the activities of a Mars migration mission would necessarily represent the vanguard of human progress, with the Earth necessarily relegated to secondary status. And indeed, many migration advocates do trumpet the mission in anticipation of the positive impacts it might have for the Earth, not because it would afford us a means to give up on Earth and move on.

# 6. Chapter conclusion

With this chapter, I hope to have achieved two things. Firstly, I have ruled out some arguments against Mars migration. My refutation of Marino's argument should also hold for other similarly fatalistic arguments, whether they rely on a kind of biological determinism as she does or some other means. Marshall's argument, at best, should convince us to approach Mars migration with caution but it does not hold up as a convincing case against the mission. My refutation of his reliance on intrinsic value ought to apply to other arguments that draw on the same philosophical concept.

As for the arguments in favour, I have identified some persuasive elements, though stopped short of agreeing that they place a strong ethical obligation on us to migrate to Mars. I have, however, uncovered several premises which might be salvaged for a pragmatist case.

With my treatment of these arguments for and against, I hope to have made substantive advances in the debate over Mars migration. There remain, however, some glaring issues which have yet to be dealt with. These concern some of the terms that some authors take for granted in the debate, as well as certain conditionalities that cannot be ignored if a convincing pragmatist case is to be made. These will be the focus of the next chapter.

# PART 2

# CHAPTER 3

# Terms of the Debate

## Introduction

Writings on humanity's future in space go back as far as the 17th Century, but the philosophical discourse around Mars migration is relatively new. And while authors in this field draw on well-established ethical traditions to formulate their arguments, some of the key terms employed in those arguments are contentious. In the second chapter, I evaluated a handful of viewpoints which I treated as representative of certain classes of arguments and recurring themes in the Mars discourse. Whether for or against, these were often typical in their usage of certain key terms. 'Survival' type arguments – whereby Mars is seen as a hedge against existential threats – regularly talk of saving 'humanity' (Green 2019) (Munevar 2019). Other key terms, such as 'colonisation' - which appears frequently in the debate – are weighted with historical import.

The purpose of this chapter is to examine these terms more closely. My aim in doing so is threefold. Firstly, I wish to bring to light what kind of assumptions might be implicit in the arguments of those who employ such terms. Secondly, I will comment on whether these assumptions hamper any attempt to build a moral case in favour of Mars migration. Thirdly, and in relation to the previous point, I aim to propose some alternative terms and 'visions' of Mars migration that may go some way towards addressing at least some of the issues uncovered. The strategy in this chapter is thus different from that of chapter 2; rather than evaluating arguments in favour and against Mars migration, I will be putting forward my view on some of the key terms of the debate – albeit with support from other authors who have written on similar topics.

With this focus on language, I am primarily taking my cue from two sources. The first is the pragmatist tradition of focussing on 'moral vocabularies.' The anti-foundationalism of pragmatism, with its rejection of "absolutely certain knowledge and universal norms and values", recognises that moral vocabularies are human inventions, situated in time and place (Swierstra 2002, 225). As Tsjalling Swierstra says in his discussion of moral vocabularies and technology, "to understand a moral concept, we have to understand the problem context which gave birth to it" (Swierstra 2002, 225). Looking critically at these moral vocabularies, Swierstra argues, may lead to "a more fruitful and effective public debate" (Swierstra 2002, 223).

This approach is not dissimilar from a conceptual analysis of the kind performed by social constructivists like Sally Haslanger. Haslanger focusses on the intertwinement of concepts and social practices with conceptual, descriptive and ameliorative analyses and genealogies of language (Haslanger 2005, 368). An ameliorative project seeks to ask why we have a particular concept (Haslanger 2005, 367). What I aim to do in this chapter can thus also be described as a descriptive and ameliorative analysis and genealogy.

## 1. Approaches

### 1.1 Moral Vocabularies

Swierstra defines a moral vocabulary as:

> [what] tells us what a human being is; what propels us to action; how reason and passion interrelate; how we should treat our fellows (and strangers); what basic rights and duties we do or do not possess; what matters in life and what is of little importance; what things may be legitimately argued over and what things on should simply accept; which values are collectively binding and which are best left to one's private discretion (Swierstra 2002, 225).

The pragmatist approach recognises that such vocabularies are a human invention, devised to cope with "situated, local problems"; our task is thus to try to examine that 'context of invention', as well as whether those vocabularies can and have been successfully transported to other problem areas (Swierstra 2002, 225 - 226). For this thesis, of particular interest is how the language of 'colonisation' has been transported from its historical roots to the realm of space exploration, and what normative implications this may have.

### 1.2 Social constructionist

Sally Haslanger comments on the disagreements that often arise over the analysis of concepts i.e whether they refer to "natural kinds, social kinds, or nothing at all" (Haslanger 2005, 365). For Haslanger, the question arises "What do we mean by X?" In trying to answer this question, Haslanger distinguishes a conceptual and descriptive answer from an ameliorative one, in which we ask "What is the point of having the concept in question?" (Haslanger 2005, 367). The ameliorative approach includes a genealogical approach, which explores the history of a concept "in order to understand how the concept is embedded in evolving social practices" (Haslanger 2005, 368). This approach is also called "pragmatic conceptual analysis" and is derived from the American pragmatist tradition (Fischer 2006).

*1.3 Normative commitments*

In explicating some of the terms of the debate in this chapter, I will be making some normative judgements. I am assuming that certain things matter, like a respect for persons. More substantively, I am endorsing certain claims about freedom which, in this chapter, I primarily understand as meaning non-domination (Pettit 2014, 11). This notion will tie-in with my claims about democracy, which is usually understood by neo—republican theories of democracy as a pre-requisite of justice and freedom (Beckman & Rosenberg 2018, 181). In addition, I will make some substantive claims about social and distributive justice – to wit, how best to distribute the rights, goods and benefits accruing from Mars migration. I take these ethical commitments as being defeasible but strong.

## 2. The Language of 'Colonisation'

*2.1 Origin and meanings*

'Colonization' comes from the Latin *colere* ("to cultivate, to till") ("Colonization" 2009), *colonia* ("a landed estate", "a farm"), *colonus* ("a tiller of the soil", "a farmer") (Dictionary, A. L. 1879), and by extension "to inhabit" (Rockman & Steele 2003). In addition, the person doing the colonising is the *coloniser*, while the person who is the object of the activity is the *colonised* (Sharp 2002). Already in the definition, then, we have some key notions packed in: an idea of working the land; secondly is the idea of an active agent (the *coloniser*) and the subject (the *colonised).*

In biology, 'colonisation' can describe "the occupation of a habitat or territory by a biological community or of an ecological niche by a single population of a species" (Onofri 2011). According to Onofri:

> biological colonization is a dynamic process that begins when unoccupied habitats, territories, or niches become available, or when organisms acquire the ability to survive and reproduce under environmental conditions of new niches, by a process of adaptation (Onofri 2011).

Note that the biological definition includes 'unoccupied' in the definition; this contrasts with the social practice of colonisation, which allows for the inhabiting of an already occupied territory by another population.

In this thesis, the definition of 'colonisation' that I am critiquing is that which describes "the action or process of settling among and establishing control over the indigenous population of an area" ("Colonization" 2020). Crucially, as Margaret and Kavita point out in their article on colonisation in the context of colonialism, the process "usually involved the transfer of population to a new territory, where the arrivals lived as permanent settlers while maintaining political allegiance to their country of origin" (Kohn & Kavita 2017).

*2.2 Social practice*

Colonisation as social practice goes back to ancient times. The ancient Greeks, the Romans, the Moors and the Ottomans are just a few examples of societies who expanded by incorporating and conquering territories and settling their peoples in those places (Kohn & Kavita 2017). Colonisation, therefore, encompasses centuries of the conquest of other continents and countries, although there are of course historical differences in how the policy was carried out, and how the indigenous peoples were perceived and treated.

In the sixteenth century, advances in navigation and shipping technologies allowed the establishing of connections between even more remote parts of the world. For the European powers, this meant the movement of large numbers of people and the retainment of political control over territories in Africa, Australia, the Americas and Asia (Kohn & Kavita 2017). Nowadays, the violence and exploitation that characterised this period are regularly critiqued by authors who accuse the former colonial powers of extracting resources through "genocide, enslavement, biological weaponry, and warfare", resulting in the deaths of tens of millions (Haskins 2018).

For this thesis, I would argue that, when discussing Mars, the periods of European colonisation and the settlement of the American West are the most salient. As will be explained, many of the ideas and concepts developed during this period have been transported to discussions about Mars by some of its most prominent advocates. Similarly, when authors object to the term 'colonisation', I would argue that these relatively recent historical periods are foremost in their minds.

*2.3 'Colonisation' as a moral vocabulary*

To what extent is 'colonisation' a moral term? Unlike more explicitly moral language, the term was not in itself employed to resolve "local problems" (Swierstra 2002, 226). As mentioned, European colonisation was largely predicated on the European powers' extracting of resources from other countries. The justification for such practises, however, was often based on moral, political and religious views (Kohn & Kavita 2017). The concept of race in particular was used to justify violence and legitimize a "hierarchy of race divided labour" (Haskins 2018). This is captured by the colonial idea of the "civilizing mission" (Kohn & Kavita 2017), a notion which underpinned much British colonial activity in the nineteenth century. The Spanish conquistadores and colonists explicitly justified their activities in the Americas as a religious mission to bring Christianity to the native peoples (Kohn & Kavita 2017). In Australia, the aboriginal population was not recognised at all; the notion of *terra nullius* – an empty state of nature – gave license to the colonists to use the land as they pleased (Goodin 2016, 11).

Thus, the practice of colonisation exhibited the same characteristics as a moral vocabulary: it determined how certain peoples ought to be treated, and who could claim rights and duties for themselves at the expense of others (Swierstra 2002, 225). And along with that, it retained its justifications for violent behaviour - often argued as benefiting the subjugated peoples, as well as those still living in the colonists' country of origin.

Haslanger outlines several different 'axes of comparison' that might be made when we consider the use of terms or concepts in context (Haslanger 2005, 369). This may include institutional v. "local" uses; what is thought v. what is practised, and so on (Haslanger 2005, 369). This split between the *coloniser* and the *colonised* is indicative of there being markedly different understandings of what it meant as a process. 'Colonisation' as social practice entailed very different experiences for those doing the colonising and those being colonised.

*2.4 Transporting the language of colonisation to Mars*

For Swierstra, the task of the pragmatist is to assess whether a vocabulary "can and should be fruitfully transported to other problem areas" (Swierstra 2002, 226). As mentioned, many authors and Mars advocates use the term 'colonisation' and explicitly draw analogies with historical colonisations. Robert Zubrin regularly draws parallels between human migration to Mars and Columbus' 'discovery' of the New World (Zubrin 2011, 256). Similarly, Jeff Bezos has said of his plans to build infrastructure in space (not specific to Mars as such) as likely to 'open up' the cosmos "the way the railroads helped open the American West" (Davenport 2018). And, as I have noted, many academics use 'colonisation' by default when discussing a permanent human presence on Mars (Slobodian 2015) (Smith, Abney, Anderson, Billings, Devito, Green, … & Potthast 2019) (Gottlieb 2019).

We might ask the extent to which transportation of such language from history to the modern-day push for missions into space is "successful, unsuccessful or still a matter of controversy" (Swierstra 2002, 225). The loaded nature of 'colonisation' as a term has not gone unnoticed and changing the language that we use to talk about Mars has been proposed by numerous authors (Smith et al. 2019, 5) (Drake 2018).

For Lucianne Walkowicz, Chair of Astrobiology at the U.S Library of Congress, even though 'colonisation' would have a different context on Mars, using such terms "erases the history of colonization *[sic]* here on our own planet" (Drake 2018). In September 2018, Walkowicz organised the *Becoming Interplanetary* conference. Amongst other topics, the conference sought to examine how the language of colonisation and "colonialist framework in space reproduces past harm from humanity's history on Earth" ("An unconference on Mars" n.d). Approaching the topic from a diverse range of disciplines, the aim was to discuss "fresh pathways for thinking about space exploration by

stepping away from the ways we usually talk about space" ("An unconference on Mars" n.d). Such an event not only demonstrates the controversy that accompanies the transportation of 'colonisation' to the realm of space exploration, but it is in keeping with a pragmatic approach to moral vocabularies; critiquing these vocabularies may lead to "a more fruitful and effective public debate" (Swierstra 2002, 223).

I would argue that the transportation of this language to the realm of space exploration may have several deleterious effects. Firstly, in the interests of social justice, I agree with Walkowicz that employing such language in the context of space exploration is problematic because it glosses over the history of colonisation on Earth (Drake 2018). Many former colonial powers struggle today with reckoning with their pasts; by using such language in the context of space exploration, colonisation is portrayed as an unequivocally good thing and thereby hinders the kind of social progress that is predicated on recognising historical injustices.

The second effect is highlighted when we do an ameliorative analysis of the term colonisation. The ameliorative project of Haslanger would ask: "What policy do we want to promote (or what objective type do we want to track), and what we do want to do with the bit of language we have been using?" (Haslanger 2005, 379). Again, we might identify a further disjunction in the usage of language if we compare 'colonisation' as used by academics and authors, as compared to 'colonisation' as used by prominent Mars advocates. For the latter, the use of the language of colonisation might be, from their perspective, a relatively benign way to tout the benefits of their technological ventures by taking a selective view of the history of colonisation and all of the ways it benefitted modern-day society. On the other hand, the term may be doing the normative work of colonisation as a social practice, by implicitly making distinctions about who will and will not benefit from the venture. Moreover, the fact that these parallels are so readily used by space technology advocates is seen by some as being indicative of a mentality that suggests human beings are somehow entitled to Mars and its resources.

Thirdly, and in relation to the previous point, Mars colonisation might be characterised by exclusion. In her discussion of the racism of historical colonisations, Haskins argues that 'colonisation' will see certain groups excluded from the benefits of the venture. Haskins admits that the dynamics would not be identical on Mars or the Moon – since they are devoid of life as far as we know it – but argues that the racist mythology that was used to justify European "would carry through to who is allowed to exist on, and benefit from, extra-terrestrial spaces" (Haskins 2018). I would argue that the conditions and context in which Mars migration may take place do lend themselves to such exclusion, particularly when used in concert with ostensibly universalising language like 'humanity'. I will examine this further in the next section.

For now, if this thesis aims to argue how we might go about making a justifiable moral case for Mars migration, then I would argue that the concerns raised here are serious enough that we ought to seek out new language with which to talk about Mars.

*2.5 Alternative language*

So far in this thesis, I have favoured the term 'migration' to describe the process of moving humans to Mars permanently. In this section, I will consider some possible alternative terms and make a case for why 'migration' is preferable. This is not intended as an exhaustive list of all possible alternatives.

- *Settlement*

  This is a term closely associated with 'colonisation' and is often used with it interchangeably. One definition of 'settlement' is the process of establishing a community in a place which is typically uninhabited ("Settlement" n.d). During the 'Great Colonization Debate' conference, 'settlement' was proposed as a replacement of 'colonisation' (Smith et al. 2019, 5). It was objected by another participant that people of European descent who moved across the North American continent "at the expense of the people who were already there" were also known as 'settlers' (Smith et al. 2019, 5). 'Settlement' is also potentially a politically loaded term due to current events in the Middle East (Drake 2018). It seems that 'settlement' therefore is too closely associated with some of the same issues of 'colonisation'.

- *Populating*

  To 'populate' is to "supply with inhabitants" ("populate" n.d). One advantage of this term is that it does not immediately summon the same historical associations as 'settling' or 'colonising'. Whilst 'populating' is a common term from biology used for different species than humans, in this context, we are primarily talking about humans. It might be objected, therefore, that it is anthropocentric. Moreover, the term may be ambiguous because it might be confused with the process of reproduction on Mars to increase the population. At the moment, it is not understood whether this is even scientifically feasible (Specktor 2018). I would argue that the term may be useful in some respects, but inaccurate if we are talking about likely scenarios in the early years of a human presence on Mars.

- *Migration*

  'Migration' is "the permanent change of residence by an individual or group" ("Human migration" 2020). It may be internal or international; forced or voluntary. Between the latter two lies an intermediate category describing the voluntary migrations of refugees escaping natural disasters, war or famine ("Human migration" 2020). Migration can thus happen for more positive reasons e.g the seeking of new economic opportunities, or more negative e.g fleeing war or persecution.

I would argue in favour of using the term 'migration', for several reasons. Firstly, it is a distinct category from other transitory activities such as migrant labour, nomadism, commuting and tourism ("Human migration" 2020). This is important for Mars since we are talking about the establishment of bases with permanent residents. Secondly, 'migration' has a naturalistic appeal. Migration is a process that has occurred throughout all of human history ("Human migration" 2020). Naturalism is one of the characteristics of pragmatism, the early proponents of which sought to bring philosophy more in line with the scientific method. Dewey, for example, explicitly rejected a view of human beings in abstraction from nature; he sought to put humans back in their natural context (Madigan 2009).

What difference would this make? I would argue that 'migration' does not carry the same descriptive and normative connotations of 'colonisation'. For instance, 'migration' does not suggest an unequal power dynamic that is implied by 'colonisation'; rather, it serves as a kind of counter-narrative, with a shift in our demographic focus to those traditionally of lesser power, namely, migrants and refugees. By adjusting our language in this way we might begin to lay the groundwork for a fairer distribution of the goods and benefits of Mars migration.

One caveat is important. By 'Mars migration', I explicitly mean 'voluntary migration'. However, this highlights that, if we were to include a wider range of biodiversity, non-human animal migration will be involuntary. 'Migration' is therefore not a perfect substitute, and a different term may become more appropriate over time. But I will propose it as a more favourable term than 'colonisation', with all of the necessary qualifications.

*2.6 Objection: Is this whitewashing?*

It might be argued that excavating the historical and moral baggage associated with 'colonisation' does not resolve the issues associated with it and that any attempt to modify language is simply whitewashing. Indeed, just as space enthusiasts might be accused of cynically employing moral language to gain wider support for their (profitable) technology ventures, it might be argued that any attempt to modify or neutralize problematic language will only aid their cause without addressing the underlying problems.

This is an important objection. I do not suggest that substituting 'colonisation' with 'migration' resolves the inherent problems of the enterprise; indeed, it is a necessary but not sufficient condition for doing so. However, I would argue that, if the critiquing of language is done in a spirit of democratic deliberation, then this may make for a more fruitful and inclusive public debate (Swierstra 2002, 223). As will be explored even further in the next section, the somewhat elitist nature of space exploration is one of the factors hindering the formulation of a morally justifiable argument in favour of Mars migration. A more fair and inclusive democratic process is one of the ways we might begin to address

the elitism and inherent injustices, and re-assessing language is a necessary step in a wider process that offers more opportunities for people to participate in deliberations about Mars migration technologies. Philosophically discussing the implications of Mars migration, and many other technology-based developments, are markedly different from much philosophical discourse which is often highly specialized and academic. Mars migration implicates the general public in such a way that demands attention to language in a way that is sensitive to the requirements of justice. This is one of the reasons I will argue for a democratic approach to ethical inquiry in Chapter 4.

## 3. Who is 'Humanity'?

In the previous section, I noted that a recurring argument of Mars migration advocates is that the effort would benefit 'humanity'. But - just like 'colonisation' - it is important to examine the descriptive and normative work done by such a term. I will begin this section with a descriptive and conceptual analysis of the term and ask who exactly the term is meant to refer to when it is employed by Mars migration advocates. An ameliorative conceptual analysis may also bring to light why it is so often employed.

### 3.1 'Humanity' vs the human genome

A conceptual analysis of the meaning of 'humanity' is especially pertinent when we consider 'survival' arguments for Mars migration. Put simply, when migration to Mars is argued as a means to 'save humanity', we can ask "Who will be saved?" Elon Musk has proposed that a self-sustaining civilization on Mars would need about 1 million people (Russel and Vinsel 2017). At the time of writing - when the world population is around 7.6 billion - this is about 0.01315789473% of people on Earth. As Russel and Vinsel point out, therefore, "Musk's concept of humanity excludes most living and breathing humans" (Russel and Vinsel 2017). And so it may be the case that, rather than saving as many human beings as possible, Mars migration advocates are merely concerned with the continuation of just enough of the human species that would allow it to continue in the case of some existential disaster on Earth (see Chapter 2). It may be that there is a difference between the "manifest concept" vs the "operative" one; the priority is not 'humanity' i.e the "manifest concept" of which we might take to mean 'human beings collectively' but rather the "operative concept", which refers narrowly to the human genome (Haslanger 2005, 370).

### 3.2 Bodily modification

Many authors entertain the possibility that we may need to modify human physiology through genetic mutation or deliberate bodily modification to survive the harsh conditions on Mars (Schwartz 2020, 201). This may include modifications such as higher tolerance for radiation; the ability to survive in low-oxygen environments; the ability to absorb solar energy, and so on (Schwartz 2020, 202). Because

of this, over time the human population on Mars may become distinct from Earth-based humans. Some advocates of transhumanism and enhancement even envision a future in which modified humans are the ones to explore space, whereas 'traditional humanity' will be left on Earth (Schwartz 2020, 212) (Bainbridge 2007, 212). In the future, therefore, the descriptive applicability of 'humanity' may be at issue; 'humanity' may become something we would no longer recognise as human (Smith et al. 2019, 6).

In his discussion of bodily modification, James Schwartz argues that what is more important than preserving the human genome is "the preservation of the continuity of human cultures and cultural processes" (Schwartz 2020, 212). So "while using modifications to enable space settlement may save "the species," these modifications will not save *us* – our cultures, our communities, our values, our hopes, our dreams." (Schwartz 2020, 212). I would argue that any morally justifiable argument in favour of Mars migration that relies on the term 'humanity' would have to endorse this view, and be able to provide a convincing story why the humanity to which they refer is the kind that Schwartz describes.

*3.3 The Elitism of Mars migration*

As we have seen, space technology is a highly specialised domain, with only a handful of private companies and world governments able to gather the necessary resources and know-how to pursue it. Numerous authors have also noted that many of its most prominent advocates are drawn from privileged sections of society; they are often white, male, Western and incredibly wealthy. It is therefore uncontroversial to say that space technology is the preserve of an elite (Traphagan 2019). In his article *'Which humanity would space colonisation save?'* John Traphagan notes that one of the assumptions of Mars migration advocates is that the interests of these intellectual and political elites are equivalent to all of humanity (Traphagan 2019, 47). I will address this assumption first and later add further assumptions that I argue are implicit in the term 'humanity'.

Are the interests of these elites truly in alignment with the 'humanity' they purport to speak for? Critics readily dismiss space exploration as adolescent fantasies, out of touch with the lived reality of the vast majority of the world's population (Vinsel and Russel 2017). What humanity needs, the argument typically goes, is time, money and expertise devoted to more everyday problems here on Earth, such as poverty and inequality (Vinsel and Russel 2017).

There are several lines of response to this kind of argument. Firstly, if we take an ameliorative approach, we can ask what purpose such a term like 'humanity' might have in this context (Haslanger 2005). What reason do Mars advocates have for so readily using such a term? A straightforward answer would be that it is in their interest to raise the stakes as high as possible, i.e., to suggest that

the entire human species is affected by the outcome of this venture, and therefore all have an interest in seeing its success. In this sense, the 'humanity' rhetoric is self-serving – it legitimates their profitable enterprises. If, on the other hand, we are generous and accept that they do have a genuine concern for the future of the human species, then the issue raised by Traphagan still holds (Traphagan 2019). I would argue that this ultimately points to several issues of democracy, accountability and justice: by what power are these elites afforded the right to speak for all of humanity? And how can we ensure that the goods of Mars migration would be distributed fairly?

In a paper on emerging technologies, Sand asks what kind of knowledge can be created from the perspective of a hermeneutic extension of Technology Assessment (TA) and how this can inform policymaking (Sand 2019, 98). Sand defines hermeneutic TA as aiming to understand the "meaning attributed to emerging technologies in societal discourses" (Sand 2019, 98). From this perspective, Sand finds that "a small group of highly educated, male, well-off people from the Northern Hemisphere has promoted the visions that attracted most of the attention of TA and the public discourse on our socio-technical future" (Sand 2019, 99). Therefore, he argues, many people do not "entertain their own vision of a desirable socio-technical future….nor do they have the means to strategically position them in the discourse and, thereby, contribute to their realization" (Sand 2019, 98). It is these people Sand speaks of as "not having a future" (Sand 2019, 99).

The insights of Sand's paper have direct relevance for the present discussion. As mentioned, several authors have written on the dominance in space technology of white, Western males such as Elon Musk, Jeff Bezos and Robert Zubrin (Billings 2019, 44). In one respect, it is not unusual that such figures garner a lot of media attention. However, this dominance begins to look more unjust in light of the range of justifications put forward by space technologists and academics alike. A term like 'humanity' captures well the disjunction between, on the one hand, the supposedly universal relevance of space migration and, on the other hand, the vanishingly small cadre of people afforded the ability to shape the "socio-technical future" (Sand 2019, 98). So Vinsel and Russel's objection may be more convincing if we view it not as being concerned with opportunity costs, but the fact that a huge number of people do not have a future (Sand 2019).

*3.4 The best interests of humanity*

A second response to the types of argument supported by Vinsel and Russel is that the critique of Mars migration can be turned back upon itself: why can one broad concern of 'humanity' be confidently asserted as more legitimate than another? And on what basis can we assert the equivalence between, on the one hand, space technology and, on the other, addressing problems of poverty and inequality? The likely response is that there is more of a clear and direct benefit for

humanity (however defined) if issues like poverty and inequality are addressed, and it is much harder to see what direct benefit accrues from a venture like Mars migration, despite what its advocates may claim. However, I would argue that such claims are somewhat disingenuous because they suggest that the resolution of problems as intractable as poverty and inequality hinge on funds and resources merely being directed in the right place. The points raised by Leif Wenar in his article, *Poverty is No Pond,* support this concern (Wenar 2011). As Wenar says, monetary investments and donations must negotiate a complex causal nexus, and there is no guarantee that things like financial aid end up where they are supposed to be (Wenar 2011). Thus, arguments of the form "Money spent on space exploration could better be spent on X" are overly simplistic.

*3.5 Alternative futurisms*

Sand's analysis shows that a handful of narratives and visions of the future are dominant in much of public discourse. As will be explained in Chapter 4, a democratic approach to moral inquiry necessarily involves participation from a more diverse range of actors. This allows the Mars debate to open itself up to a greater plurality of visions about the future. We might call these *alternative futurisms*. This includes – though is not limited to – speculations about the future by groups who have traditionally been marginalized.

Just one notable example of this is "Afrofuturism", a subgenre of philosophy, literature, fashion, music and other aesthetic forms (Ogbunu 2020). This genre includes "visions of the future – including science, technology and its cultures in the laboratory, in social theory, and in aesthetics – through the experience and perspective of African diasporic communities" (Ogbunu 2020). One recent and highly successful example of a work in the Afrofuturist genre is the film *Black Panther*, released in February 2018. The film is set in the fictional Wakanda, a futuristic country in Africa with the most advanced technology in the world, and the only African country not colonised by Europeans. By presenting this alternative narrative of past and future, the film not only challenged stereotypes of Africa, but posed questions about the future role of technology in society, and invited audiences to understand the impact of forces like colonisation on social progress (Strong & Chaplin 2019, 58 – 59).

Afrofuturism was also prominently featured during the *Becoming Interplanetary* conference I mentioned in previous sections. Its role in the discussions here can be understood as a way to reframe standard narratives of the technological future as white Western futurism and not a "position from nowhere" ("An unconference on Mars" n.d). By making space for these alternative futurisms, the participants questioned assumptions about progress and modernity and focused on groups traditionally considered as being at the margins of these forces ("An unconference on Mars" n.d).

I argue that these kinds of alternative futurisms are necessary tools for challenging standard narratives about the future and of Mars migration. Admitting such visions in the discourse is a recognition that the visions of the technological elite do not exhaust all possible ways of discussing the future and, specifically for Mars, what migration might not like, or if it is even a desirable goal at all.

*3.6 Bodily diversity*

A further issue arises with the conceptual meaning of 'humanity' when we examine the history of space exploration. Wells-Jensen and colleagues observe that the process of personnel selection for space missions has a bias towards able-bodied persons. Even the smallest physical disabilities "act as an automatic barrier", because the disabled are viewed as liabilities in the unforgiving space environment (Wells-Jensen, Miele & Bohney 2019, 51). Consequently, typical astronauts represent "a kind of cultural and physical homogeneity" (Wells-Jensen et al. 2019, 50). The authors see this as detrimental not only to those excluded but to the mission as a whole since designs of spacecraft more accommodating to "physical and sensory atypicality" would make it safer for everyone (Wells-Jensen et al. 2019, 50). The authors understand disability as a social construct, stemming from institutions and built environments "which are not properly designed to accommodate physical and sensory atypicality" (Wells-Jensen et al. 2019, 51).

And so, along with being fronted by a socio-political elite, the selection process that determines who is allowed to access space is also characterised by modes of exclusion. Of course, there is a limit to how far we can extrapolate from the past into the future, but it is worth asking whether such patterns of exclusion might be replicated in a Mars migration mission. In the early decades, there would be a great deal of work to be done in the way of making livable spaces for human beings. Would there be a bodily bias in who is selected to be a part of this early migration mission? And will habitats constructed on Mars embody a kind of architectural ableism? If the primary aim of a Mars migration mission is solely to preserve the human genome, for example, then bodily diversity might not be a top priority.

Bodily diversity is just one example of an 'alternative vision' (Wells-Jensen et al. 2019) that may look different than the kind that dominates the Mars migration discourse; there could be many more. I have chosen this example to illustrate the kind of gatekeeping that characterizes space exploration in general; we cannot discount the possibility that it will affect a Mars migration mission too. Such gatekeeping is highlighted when we examine the ostensibly all-encompassing language of 'humanity'.

## 4. Chapter conclusion

This chapter has demonstrated that there are issues common to 'humanity' and 'colonisation'. Such language draws attention to the exclusionary, often elitist nature of space exploration. If we are

concerned at all with a basic respect for persons and with matters of social justice, I argue that addressing this state of affairs is a necessary condition for a morally justifiable case for Mars migration. In the next chapter, I will argue that fostering opportunities for 'intelligent moral inquiry', and a more inclusive and democratic process may allow for a greater plurality of visions as to what Mars migration might look like, and allow for those excluded from space exploration to have a greater say.

Finally, it should be repeated that the purpose of this chapter has not been simply to identify and whitewash fraught language; a critic of Mars migration may still find much that is objectionable even in the absence of controversial terminology. And there are likely more terms in the debate worth examining, as well as 'alternative visions' worth considering.

# CHAPTER 4

# A Pragmatist Reframing of Mars Migration

## Introduction

In the second chapter, I evaluated a handful of arguments for and against Mars migration. In this chapter, I will return to some of the most salient premises from that chapter - this time, with a pragmatist perspective. I will argue that by reframing our ethics as 'experimental inquiry' - as articulated by John Dewey – we can take heed of the concerns articulated in those arguments without arriving at stringent requirements for or against Mars migration. Amongst other things, this entails moving away from a reliance on traditional philosophical ethics. A Deweyan instrumental approach has several advantages and can provide a clearer normative direction in our approach to Mars migration because of its focus on consequences. It can also be more adaptable to the kind of dramatic socio-technical changes that Mars migration entails.

I will also elaborate further on some of the key findings of previous chapters, in which I stated that the language in the discourse (Chapter 3) point to more substantive issues stemming from the injustices inherent in space exploration - Mars migration being a paradigm case. Accordingly, I will argue in favour of John Dewey's views on democratic institutions as the best means for fostering intelligent moral inquiry (Dewey 1927). My argument here will be that, with Mars migration so prone to elitism and inequalities in the distribution of benefits, and with the Mars discourse so dominated by a handful of narratives of what Mars represents, a more inclusive, democratic approach to moral deliberation would stand a better chance of addressing these issues, and reflect the plurality of ways that the future on Mars could be envisioned.

Having made these points, I will address my main research question of whether Mars migration can be morally justified and make suggestions for further research based on this thesis.

## 1. Mars Migration as 'Experimental Inquiry'

For Dewey, habits are key to how we direct conduct but, when they fail, we use instrumental value judgements. These have three aspects. The first is as a guide to action – to resume activity when that activity has been interrupted by a problematic situation (Dewey 1939, 221 – 2). The second sees good and actions in a wider context – that is, valued reflectively, in relation to their consequences (Dewey 1939, 209 – 213). Finally, just as scientific hypotheses uncover new information about the world, value

judgements are tools that uncover new evidence about what to value (Dewey 1922, 19-26; Dewey 1925, 88 – 9).

For Dewey, there is a parallel between ethical and scientific inquiry. Propositions generated by value judgements ought to be tested empirically. Thus, in contrast to the "fixed goals and rules" of traditional normative theories, Dewey's method of experimental inquiry is both theoretical and practical (Dewey 1957). With this kind of methodology, we can recast the arguments for and against Mars that I considered in Chapter 2.

*1.2 Survival of Humanity*

In Chapter 2, I noted that there are some uncertainties associated with the argument that humanity would be saved from some existential threats by a human presence on Mars. These uncertainties blunt the categorical force of the duty; at best, the establishment of a human presence on Mars is a case of supererogation.

The difficulties of 'Survival of Humanity' arguments are further compounded by the findings of Chapter 3, wherein 'humanity' (supposedly protected from annihilation by being present on two planets) was revealed as a term that masks many biases and inequalities, as well as being descriptively inadequate, for reasons I have given.

The pragmatist can agree that certain actions may stand a chance of protecting some or even all the human species from certain threats. Some of these actions will be technology-based, whether building Earth-based asteroid detection and deflection technologies or a human presence on Mars. However, an important difficulty arises if we frame 'Survival of Humanity' type arguments in Deweyan terms. A hypothesis that goes something like, "A human presence on Mars would save humanity from annihilation" has the potential to be experimentally tested. However, it might be argued that the optimal test for such argument is the existential threat materialising. I am assuming we would not wish for this to happen just to test our hypothesis. So whilst a Deweyan reframing of the argument might avoid the kind of strict requirements characterised by, for example, a more duty-based approach, there is an issue of how we might go about valuing not only the effectiveness of a human presence on Mars as a bet-hedging measure, but its wider consequences.

The advantage of a Deweyan experimental approach, however, is that it allows for flexibility and adaptability to changing circumstances by not being overly stringent about which course of action to take. Put simply, the pragmatist might allow that multiple technologies, both Earth-based and Mars-based, can be built in order to serve as a bet-hedging measure against annihilation, but allows for us to stay open to the possibility that our plans and intentions might change; that the efficacy of such

technologies might not pan out, and that there may be wider consequences to pursuing such an endeavour that may prompt us to re-evaluate our goals. By remaining sensitive to context, we might be better able to tailor our response to the particulars of whatever existential threat might materialize. On the other hand, a human presence on Mars may produce negative consequences that we deem as too high a price to pay and therefore cancel or curtail the project. Or some other means of ensuring that humanity survives into the future might be uncovered. Ultimately, we escape the overly stringent demands of a duty-based theory and retain responsiveness to changing and unpredictable circumstances on Earth and Mars. There do remain challenges over how to ensure that Mars migration as a means of survival benefits as much of humanity as possible. This goal may be served by a democratic approach to moral inquiry, which I will explain later in the chapter.

### 1.3 Settle space to help the Earth

Cockell's argument – that Mars migration and general space exploration could benefit the Earth - lends itself to a pragmatic case for Mars migration because it generates the kind of testable hypotheses that characterise an experimental inquiry approach. In some respects, Cockell's argument can be framed as a kind of 'Survival of Humanity' argument, but it parses it out in a way that is more focussed on consequences for the Earth. In this respect, it can be thought of as avoiding some of the problematic aspects of 'Survival of Humanity' arguments, particularly the accusation that Mars migration would only 'save' a vanishingly small proportion of the total human beings. Instead, the benefits can in theory be shared between the inhabitants of Earth and Mars.

The argument has more of a consequentialist approach and, therefore, can more comfortably be reframed from the point of view of Deweyan experimental inquiry. By shifting focus back to Earth, then, we can see how Cockell's argument can make similar claims to 'Survival of Humanity' arguments but allow for the generation of hypotheses that are more easily testable, and which can be valued with a 'humanity' in mind that is more comprehensive. Consequences of space exploration on Earth would be more accessible and intelligible for a much wider range of people as we could make informed judgements about the impact of space exploration technology on daily life. Furthermore, even though Cockell's argument is motivated by support for environmentalism, it does not rely on abstract notions such as intrinsic value, which do not fare well in a pragmatist account.

### 1.4 Mars has intrinsic value

In Chapter 2, I argued that Marshall's paper raised some important points about the risk of contamination that human activity could pose to Martian microbial life – the existence of which, as of yet, has not been ruled out (McKay 1997). Where I mainly disagreed with Marshall was in his reliance on intrinsic value.

The notion of intrinsic value does not accord well with a Deweyan pragmatist perspective either. For Dewey, standards for valuing cannot be "devised external to practise" (Anderson 2019). Dewey's contextualism rejects intrinsic value because it "tears the practice of making value judgements out of the contexts that give them meaning and point" (Anderson 2019). In other words, it does not make sense to attribute value to something and claim it is not a human invention (Marshall 1993, 233). Nonetheless, we might accept the thrust of Marshall's argument without the notion of intrinsic value.

The discovery of life on Mars would indeed have great scientific value, and a human presence on Mars poses a real risk of contamination. However, the fact that it is a testable scientific hypothesis means it accords well with a pragmatist approach. Notwithstanding the probes that have already been sent to Mars uncontaminated, we arguably have the ability to protect Mars from further contamination through special protocols and by proceeding with cautious incrementalism that allows us to track the impact of our presence on Mars. As I have already described, a Deweyan approach to ethics says that "if one acted in a particular way (or valued this object), then certain consequences would ensue, which would be valued" (Anderson 2019) (Dewey 1922).

Approaching ethics as a form of inquiry involves "using the action decided upon as a means for uncovering new evidence about what to value" (Anderson 2019). Scientific inquiry on Mars may lead to unexpected discoveries, or it may lead to nothing at all. The point is that, if we wish for normative guidance, it is better to treat our ethics as a kind of inquiry akin to scientific inquiry, rather than relying on notions of intrinsic value that do not provide a clear direction at all. Moreover, the adaptability of experimental inquiry means that we can still investigate the possibility of Martian life without allowing that the valuation of Mars as a place of scientific importance is the only way to view the planet. Acting on our value judgements uncovers new evidence, and thus new valuations of what Mars could be.

*1.5 Humanity is not Prepared*

Lauri Marino's argument raised some important points about the hubris of humanity but, for reasons I explained in Chapter 2, I did not find her causal explanation convincing. From a Deweyan pragmatist point of view, however, Marino's argument provides a basis for an experimental method that generates testable value judgements.

From a moral point of view, perhaps one saving grace of Mars migration is that the process is likely to be slow and incremental. In the initial years and decades, the number of people living on the planet will be relatively minuscule compared to the population on Earth. The territories occupied will cover an exceedingly small proportion of the total land surface of Mars, and so the environmental impact on the planet will likely be similarly small. Activities on Mars will, of course, have consequences for the planet – particularly with a mission architecture so dependent on ISRU - but I would argue that,

from a Deweyan perspective, we will have opportunities for evaluating the consequences of our actions on Mars and deciding if the course being pursued should be continued. The point of making value judgements is to "alter or guide our valuings" (Anderson 2019); if our impact on the planet is determined as negative, there may be opportunities to re-assess.

These may seem as somewhat obvious and unremarkable claims. However, it is important to remember that Marino's objection (which I took as representative of a class of similar objections with a fatalist bent) might prohibit a human presence on Mars indefinitely on the basis that we are doomed to repeat past mistakes. Marino is likely correct in saying that we should not assume that we will "do better next time" (Marino 2019, 17), but neither should we assume that we will do just as badly or worse. Here again, we can accommodate the premises and concerns of an objection to Mars migration without accepting that it should forbid the mission indefinitely. Rather, we can act and keep open the possibilities that our actions there will uncover new evidence and things to value. The consequences of acting on Mars migration guides the formation of new valuing (Anderson 2019).

That being said, the findings of Chapter 3 serve as a warning against some of the same concerns as Marino's. Mars advocates' readiness to adopt the language of 'colonisation' raises concerns about destructive tendencies and rampant resource exploitation, but I would argue that our focus should not be on some cognitive predisposition to destructiveness (Marino 2019); rather, the focus should be on the historical forces underlying past colonisations, some of which may play out similarly on Mars. As I have suggested in this thesis, one necessary but not sufficient way to mitigate this possibility is by reassessing the language we use in regard to Mars migration. We also should be mindful of our actions uncovering new evidence which can guide our action (Anderson 2019). We ought to proceed with Mars migration cognisant of the fact that we will change the Martian environment in new and novel ways, and it is up to us to take heed of those consequences (in a pragmatic sense) and adjust our behaviours accordingly.

## 2. How Experimental Inquiry Furthers the Mars Debate

Having revisited some of the main arguments for and against Mars migration from a Deweyan pragmatist perspective, I will explain further the benefits of such a perspective, and how it can help to move the debate forward.

### 2.1 Focus on consequences

In the literature I have reviewed, the arguments that have accorded well with a pragmatist approach are those that focus on harms or benefits. This is unsurprising since pragmatism has more in common with consequentialist ethics than deontology or virtue ethics. Unlike those theories, pragmatism shares the consequentialists' view of consequences as being integral to moral thought.

One of the ways in which it differs, however, is that it does not settle on "fixed answers to questions of the good" (Anderson 2019). Whilst Dewey says that consequentialist theories like hedonism, for example, contain methodological insights e.g. that pleasure can be seen as a sign of what is valuable, its theoretical demands do not reflect the "complex character of our experiences of pleasure and pain" (Anderson 2019). Anderson notes that informed desire theories of the good come closer to Dewey's account, but that theory commits the same error as hedonist theories in omitting the importance of character in identifying the good (Anderson 2019). Neither can a method of inquiry become a fixed criterion of value because inquiry never ends, and what we reflectively desire and approve of desiring may alter in light of further inquiry (Talisse & Aikin 2008, 122).

Thus, Dewey's pragmatism does not assume to have ideas of the good already settled; we may discover that novel ventures like migrating to Mars uncovers new ideas about the good. As such, it allows for action with flexibility, retaining the capacity to change course in light of our evaluations of the consequences of acting on our value judgements. With such an approach, we might overcome the intransigence of arguments that flatly prohibit Mars migration, whilst keeping some of the same concerns in view.

The ongoing process of Mars migration will have consequences, which will themselves be valued. We might rethink how we go about it if we decide those consequences are too high a price to pay. Conversely, the negative consequences feared by Mars migration critics may never come to fruition. At the very least, critics or supporters of Mars migration will have firmer grounds for many of their claims, and potentially gain wider assent for them. This last point is key: by judging things in relation to their actual consequences, we open up the act of valuing to a wider range of actors, and thereby a wider range of visions about the future of Mars. Hence experimental inquiry should also be a form of democratic inquiry. I will return to this point in a later section.

For Dewey, the presumption of unquestioning obedience to traditional philosophical ethics is "a formula for perpetual immaturity, because it cut[s] off all possibility of learning better ways to live by experimenting with them" (Anderson 2019). Thus, while traditional ethics certainly can provide insights into what is of value in the Mars debate, they often argue against experimental possibilities before they have been attempted, and thereby close down possible futures of what Mars could be. Indeed, it is one of the central claims of this thesis that a technological venture as novel and complex as Mars migration demonstrates that traditional ethical theories can be overly dogmatic in the face of rapid technological change and an uncertain future.

*2.2 Reciprocal determination of means and ends*

Following on from the previous section, a common objection to Dewey's instrumental theory of value judgements is that, because it does not have a notion of final ends or intrinsic values,  it only "values things as means only" (Anderson 2019). The danger is that the theory reduces to a form of Humean instrumentalism, whereby our ends are given only by our desires and immediate likings, and the question then becomes merely how to satisfy them (Anderson 2019).

Dewey's reply to this kind of objection is particularly illuminating in the context of a Mars migration discussion:

> [t]he character and value of means and ends was reciprocally determined. We do not first already have an end in view, with the only question how to achieve it. We lack a complete conception of our end until we have a complete grasp of the course of action that will take us there (Anderson 2019).

This reciprocal determination of means and ends articulates why Mars migration is seen by so many as a worthy aim; the costs of achieving the goal inform how we value the end. It is not simply that we value having a human presence on Mars, but we value the technical, organisational and logistical challenges required to carry it out. But since we have not yet overcome those challenges, we do not have "a complete conception of our end" (Anderson 2019). This type of reasoning surely informs arguments that tout the positive benefits that moving towards Mars migration would bring; this is not just an argument for the human presence on Mars itself, but all of the stimulating effects of building towards that goal.

From this view, reasoning about Mars migration in a way that values the ends only "cannot provide the basis for rational action" since we would be acting on "radically truncated judgements" (Anderson 2019). But this applies equally to arguments in favour or against Mars migration. As I have argued in the previous sections, we should not be making theoretical commitments ahead of time, nor should we base our actions or moral reasoning or final ends, since we cannot know enough about them beforehand. The radical novelty of Mars migration brings this point into sharp relief.

*2.3 Overcoming methodological dogmatism*

A reliance on traditional philosophical ethics engenders a kind of dogmatism that hinders the debate from moving forward and cannot entertain a plurality of visions for Mars. I will explain more in this section why a shift to pragmatism brings about a methodological advantage that can overcome such intransigence.

In the face of a novel situation, we cannot assume what kind of theoretical conceptions should inform our analysis. This is one of the key insights of early pragmatism. Like James and Peirce, Dewey questioned any number of presuppositions that philosophers started their philosophical examinations with, and how they entered the practice of philosophy (Hildebrand 2018). As Hildebrand explains:

> We simply cannot know—and should not assume—which terms and theories are *necessary* for an analysis of a novel situation. Nevertheless, much philosophy has assumed such necessities. We may call this the assumption of a "theoretical starting point". It has produced endless dialectical exchanges; it has caricatured and hollowed out many complex and changeable subject matters. Overall, it has isolated philosophy from a more thoroughgoing empiricism which could engage with humanity's most important problems (Hildebrand 2018).

For Dewey, philosophy should be informed by "experience as method":

> It warns philosophers to recognize that while intellectual terms may *seem* "original, primitive and simple" they should be understood as the historically and normatively situated "products of discrimination and classification" (Hildebrand 2018) (Dewey 1925).

Thus, by approaching the question of Mars migration armed with the kind of presuppositions characteristic of traditional philosophical ethics, we risk isolating philosophy from the kind of engagement that could usefully serve the enterprise. This point is especially salient given that Mars advocates like to promote Mars migration as beneficial to all of humanity (Musk 2017). If the philosophical justification for that argument is grounded in such a theoretical dogmatism, there is a risk that such arguments can be counterproductive.

### 2.4 Addressing elitism

As I explained in Chapter 3, space exploration is largely the domain of a highly specialised elite, with Mars migration being a paradigm case. Whilst philosophy is a markedly different domain from space technology, the charge of elitism might apply there too. Indeed, Dewey's motivation for distinguishing his pragmatism from traditional philosophical ethics partly stemmed from concerns about elitism. For Dewey, traditional ethics' "preoccupation with reducing the diverse sources of moral insight to a single fixed principle subordinated practical service to ordinary people to the futile search for certainty, stability and simplicity" (Anderson 2019). Traditional philosophical ethics thereby "served the interests of elites at the expense of most people" (Anderson 2019).

Philosophical elitism can also be brought to light when we follow the pragmatist convention of excavating the context of invention of certain theories and principles, as I first discussed in Chapter 3. An example provided by Swierstra illustrates this point. Swierstra notes how the idea of human beings

as "born free and equal", propounded by philosophers like John Locke, only in fact had a "small part of the population in mind" i.e a well-off, white Western European male (Swierstra 2002, 225). Locke's formulation, says Swierstra, must be understood in the feudal context in which it was created; the individual he defined was to defend certain citizens from the feudal state (Swierstra 2002, 225). By examining the context of invention of ethical theories we might also make similar discoveries – that supposedly universal language applies to a smaller group of people than it purports to.

The social circumstances in which certain moral theories arose was a prime concern for Dewey, as he believed that understanding the social context would expose the limitations of the theory. Thus, "theories that make sense in certain contexts may not make sense in others" (Anderson 2019). But the social embodiment of philosophical doctrines is not just contextually dependent; rather, Dewey argued that they often "rationalize and reinforce stultifying and unjust social arrangements" (Anderson 2019).

By putting traditional philosophical ethics in service of a debate around technology that is already characterised by elitism, then, the whole project looks increasingly remote from the concerns of ordinary people. This is compounded by the methodological dogmatism I discussed in the previous section. Furthermore, looking to traditional theories may not provide resources to challenge the injustices and inequalities that I have highlighted throughout this thesis. This may have two main consequences. Firstly, the goods and benefits stemming from Mars migration may flow disproportionately to a small section of society. Secondly, as I have noted in Chapter 3, the visions of that elite group can largely dominate the discourse, thereby perpetuating the inequalities already built into Mars migration. Putting traditional ethics in service of this discourse may legitimate it as the dominant narrative. Regardless of whether authors conclude that we should or should not migrate to Mars, the visions of Mars at issue flow from this same narrative. A pragmatist approach, which frames the debate as experimental inquiry, may go some ways towards addressing this elitism.

## 3. Democracy and Intelligent Moral Inquiry

As I have argued, Deweyan experimental inquiry can be a useful tool for addressing some of the issues of traditional ethics. I would argue, however, that this should also be complemented by the principles of Dewey's political philosophy. This emerges from his ethics, and it reflects his views on ethics not as the result of individual reflection but emerging from the demands of others (Anderson 2019). He argued in favour of democracy as the means by which we practise "intelligent moral inquiry" (Anderson 2019). I will argue that this democratic element is an essential condition for building a morally justifiable case for Mars migration since it sets the stage for addressing the inherent issues with the mission.

As mentioned, Dewey's experimental method "treats norms for valuing as hypotheses to be tested in practice, in light of their widest consequences for everyone" (Anderson 2019). This requires democratic institutions that allow people to practise moral inquiry together (Anderson 2019). Anderson outlines how Dewey envisioned this to work:

> To implement this method requires institutions that facilitate three things: (1) habits of critical, experimental inquiry; (2) widespread communication of the consequences of instituting norms, and (3) extensive sympathy, so that the consequences of norms for everyone are treated seriously in appraising them and imagining and adopting alternatives (Anderson 2019).

Dewey's views on democracy reflect the wider pragmatic tradition of shifting focus from the "context of justification" to the "context of discovery" – the distinction between which is still sharply divided by traditional ethics (Keulartz et al. 2002, 13). For traditional ethics, the emphasis remains on the justification of moral judgements rather than "new, hypothetical constructions, with which to deal with emergent moral problems" (Keulartz et al. 2002, 13). Rather than the individual Cartesian ego being the driving force behind this process, it is the "community of inquirers" who engage in a learning process "aimed at lifting practical wisdom over the whole breadth of the social spectrum to a higher level" (Keulartz et al. 2002, 13). Here "It is important not to exclude any group at all from debate and decision-making" (Keulartz et al. 2002, 13). This emphasis on inclusion has both a cognitive and normative purport; cognitive, because the chance of a solution to emergent problems increases the "broader the range of relevant arguments is"; normative, because with social conflicts being the manifestation of emergent problems, these may be viewed more positively as "instigators to invention" (Keulartz et al. 2002, 13). Importantly, the possibility of conflicts leading to polarization is why no group should be excluded from decision-making (Keulartz et al. 2002, 13). As I have made clear, patterns of exclusion and the inequalities that could result from them are ongoing issues in space exploration and Mars migration. This emphasis on inclusion is therefore crucial.

Even with such mechanisms in place, however, I do not suggest that a consensus on Mars migration will suddenly arise. I am also not arguing for a kind of convergence view of moral truth, whereby moral deliberators converge upon the same idea if operating under ideal epistemic conditions (Talisse & Aikin 2008, 21). A morally justifiable solution is, however, more likely. And, given the inequalities that characterize Mars migration and its associated discourse, we stand a better chance of being able to morally justifying the mission with more perspectives and visions taking part in moral deliberation. The focus, then, is on the process rather than the result. For Dewey, the process is best served by democracy (Dewey 1940, 3).

*3.1 Habits and Practicalities*

One vital question is, what mechanisms and social institutions should we create to implement Deweyan democracy? For Dewey, two critical domains were education and civil society. Habits are the key to Dewey's thought, and instilling habits of experimentation, imagination, independent thought, critical inquiry and sympathy for others is best done through education (Dewey 1916; 1922). In terms of civil society, Dewey advocated, amongst other things, for improving communications among citizens and between citizens and experts. This was for people to be informed about the experiences of those from different walks of life, and about scientific discoveries (Dewey 1927). Instilling habits and improving communications in the modern context would therefore surely need to consider the modern world of mass communication via the internet and other modern media. These are critical means by which citizens can be exposed to the experiences of others, and also has a significant influence on scientific literacy and knowledge of scientific discoveries. Promoting greater communication between the public and those organisations involved in Mars migration is surely necessary.

As well as communication, democracy also requires that there be accountability. As a government agency, NASA is subject to public scrutiny; the same cannot be said of the private companies currently spearheading Mars migration efforts. As I have explained, however, companies like SpaceX hold several government contracts. Because of this link, we might then demand a degree of accountability for these companies and a means to interrogate any future planned missions – perhaps through citizen's assemblies, or some similar mechanism.

The Deweyan democracy I am defending is deep, subsantive and communicative, and constitutes a way of life (Talisse & Aikin 2008, 134). This means that "The struggle for democracy has to be maintained on as many fronts as culture has aspects: political, economic, international, educational, scientific and artistic, and religious" (LW13: 186, Talisse & Aikin 2008, 134). In other words, the democratization of moral deliberation over Mars does not happen in isolation but in a wider context in which democratic norms are instituted in all aspects of life. It is beyond the scope of this thesis to discuss all the ways in which habits and institutions could be developed to foster democracy in all of these areas, but this could be a promising avenue of future research.

## 4. Can We Morally Justify Mars Migration?

My primary research question for this thesis was "Can human migration to Mars be morally justified?" I hope to have demonstrated in the preceding sections and chapters that answering this question is not a matter of finding the most convincing argument in favour of Mars migration. As stated in the introduction to this chapter, I am approaching the question from a pragmatist point of view and

therefore am more concerned with the methods of moral deliberation than the result (Talisse & Aikin 2008, 119). This reflects the tradition of classical pragmatism, which is "much less interested in the end products of research and more interested in the research process itself through which scientific statements and moral judgements come about" (Keulartz et al. 2002, 13).

Whilst I have evaluated several arguments in favour and against Mars, I have not endorsed one of them above all others. At the very least I hope to have moved the debate forward by ruling out certain arguments as being persuasive enough to prohibit Mars migration - though they do contain some premises that warrant attention. Those arguments in favour that I have endorsed (with qualifications) accord well with a pragmatist approach, but such an approach would not have us assert moral obligations to migrate to Mars. Viewing our moral deliberations as a form of inquiry shifts our focus to the consequences of taking certain actions, always aware that what we value may change in light of new circumstances. I argue that this is a much more sensible approach to something as radical and novel as Mars migration, as we are then not assuming dogmatic theoretical commitments ahead of time, nor purporting to have a fully articulated conception of our ends before we know what is required to get there (Anderson 2019).

A morally justifiable case for Mars migration is currently hindered by a debate that trades on problematic or ambiguous terminology, which I have discussed in Chapter 3. Excavating terms like 'colonisation' and 'humanity' highlights some of the inherent injustices and inequalities of Mars migration and space exploration in general. In order to make a morally justifiable case, attention to the kind of moral vocabularies we use is needed. I have emphasised, however, that making linguistic changes is necessary but not sufficient for the building of a more robust moral case for Mars.

As well as an approach to ethics that eschews fixed principles and abstract terms, a more democratic approach may help to ensure that groups are not excluded from the process of moral deliberation. This point of inclusion is especially important because improving methods of inquiry in this domain requires confronting the nature of power dominance on the technological side of Mars migration. The highly specialized and elitist nature of the enterprise means not only that the goods and benefits of Mars migration might accrue to a small minority, but that only a few visions of Mars migration circulate in public discourse. In other words, moral justification cannot happen without addressing issues of justice and freedom first, and democracy is a prerequisite to addressing those issues.

I argue that Mars migration can therefore most likely be justified, but only if these minimal conditions are met. Normative direction for what to do about Mars migration comes from our valuation of consequences and their impact on the widest number of people, rather than adherence to certain principles or abstract concepts. To trade on such principles is, to an extent, a way of narrowly defining

what Mars migration can and should represent in our current circumstances. Approaching the Mars debate democratically and as a form of inquiry allows for dynamism and flexibility in the face of an unprecedented "problematic situation" (Dewey 1939, 221 – 2).

*4.1 Future research*

These conclusions leave some outstanding questions and thus possible avenues for future research. For example, we might investigate how alternative futurisms could gain more attention and prominence in public consciousness as a means to challenge traditional and dominant narratives about the past, present and future. This may include exploring the ways that the arts could be better funded and supported in order to encourage output in the genre of alternative futurisms, as well as public forums for discussing them.

Another important area that I have not addressed is international justice. Clearly, issues I have raised in this thesis go beyond simply the private companies and space exploration programs originating from the United States. The issues of exclusion, as well as questions over the distribution of the benefits of Mars migration play out at the international scale too. As we have seen, all-encompassing language like 'humanity' is regularly invoked in discussions of Mars migration, and pitching the debate at such a level surely requires an account of how other national governments and companies are to be included in the community of moral deliberation. Future research into this area might therefore explore how a just distribution of the benefits of Mars migration might play out on the international scale, and how a democratic mode of moral inquiry can operate within and amongst countries lacking democratic political cultures.

Finally, the adoption of a pragmatist ethic for the debate on the morality of Mars leads to further questions about what kind of ethical guidance we might need in guiding life in a Mars habitat. I suspect that many of the appeals to non-foundationalism in this thesis would apply also to a society beyond Earth. This question has been partly addressed by Tony Milligan (2016) and there is surely much more to be said on the topic. This may in turn require an investigation of how Martian land is to be divided and used and what kind of legal frameworks are needed.

## 5. Chapter conclusion

In this chapter, I have reframed the arguments from chapter 2 from a Deweyan pragmatist perspective which views ethics as experimental inquiry. This is a non-foundational approach to ethics, which sees our value judgements as testable hypotheses that must be investigated empirically (Anderson 2019). In the case of the Mars debate, this means that we can still take seriously some of the concerns raised by the authors writing for or against Mars migration, but that we do not end up with an argument that generates a moral obligation; nor we are reliant on pre-defined ideas of the good, or notions of

intrinsic value. Those arguments for and against that have fared the best are those which posit future consequences - these can at least be tested and valued to a certain extent.

I have also emphasised the importance of experimental inquiry as being fostered by democratic processes, such that the widest possible range of voice can be heard in the Mars debate. This is especially important given the conclusions I have drawn thus far in this thesis; despite its advocates regularly insisting that Mars migration will benefit 'humanity', space exploration is characterised by injustices and biases, both in terms of the technology and the narratives about what Mars represents. Not only that, but a narrowly defined portion of humanity is likely to benefit. A democratic approach is thus crucial to addressing some of these concerns and, married with an approach to ethics that expects our value judgements to change over time, we end up with a dynamic and flexible approach to Mars more appropriate to the novel nature of the enterprise.

# CONCLUSION

Some Mars migration advocates predict that humans will be sending people to Mars as soon as 2027. This seems unlikely with the current rate of technological progress but, even so, Mars migration is a topic gaining greater prominence in mainstream media as well as academic discourse, and the enterprise may very well become a reality in the coming decades. As such, people working in the field of space exploration and Mars migration might need to engage with the kind of philosophical questions I have raised in this thesis in the not-too-distant future. However, I have highlighted just how much philosophical work needs to be done to address some of the inherent problems with Mars migration and its associated discourse.

In Chapter 2, I evaluated a handful of arguments both for and against which I took to be broadly representative of typical positions that authors take regarding Mars – there are others, of course. Migrating to Mars as a way to 'save humanity' is, I have argued, a morally praiseworthy act. The difficulties and ambiguities associated with its framing as a moral obligation, on the other hand, means that it is better to steer clear of such a stringent conclusion. The argument that developing the technology needed for Mars migration will benefit environmentalist efforts on Earth has some convincing points (Cockell 2007), though I argued that Cockell overstates his case somewhat; the complexities of addressing the environmental crises on Earth go beyond the development of sustainable technologies. Nonetheless, such an argument may avoid some of the more grandiose claims of 'survival of humanity' arguments whilst still making some similar claims.

As for the arguments against, I conceded that Marshall's concerns about contamination of Mars are important and should be taken into consideration. Where I took issue was with his reliance on intrinsic value, due to its incoherence and implicit anthropocentrism. Lori Marino's scepticism about the future of humanity also raises some important concerns which are not easily dismissed; however, her view has a fatalist bent which goes beyond the empirical evidence she marshalls in support of her case. Moreover, I argued that the forces responsible are contingent and historical – not, as she argues, determined by biology.

In Chapter 3, I looked more closely at two of the key terms that regularly circulate in the debate around Mars migration: 'colonisation' and 'humanity'. For the pragmatist, investigating the moral vocabularies at work in any debate is crucial, and it is important to understand the origin and transportation of such terms to other domains (Swierstra 2002). Part of my analysis in this chapter was also done from the point of view of social constructionism and I conducted a conceptual, descriptive and ameliorative genealogy of the term to understand how and why 'colonisation' is used

when discussing Mars. I concluded that the term's evocation of negative historical events make it too fraught a term to usefully serve the Mars debate. These events include land and resource exploitation, racially charged ideologies and assumptions of cultural superiority; and, crucially, a legacy of exclusion which saw a denial of rights to certain groups. Accordingly, I proposed 'migration' as a far less problematic term.

'Humanity' is also a common term employed in the Mars debate and is demonstrative of the high-stakes manner in which planetary migration is often discussed. I found that, despite what some Mars migration advocates would like to portray, it is unlikely that all of humanity can and will benefit from Mars migration. This is not only because of the comparatively small number of humans that would stay on Mars for the foreseeable future but because of the biases inherent in space exploration in general. The ableism that has characterised space exploration up until now is just one example of such biases.

In Chapter 4, I revisited some of the main premises from the arguments in Chapter 2 from the perspective of John Dewey's pragmatism which views ethics as 'experimental inquiry', an empirical approach in which we make value judgements which must be tested by experience (Anderson 2019). I argued that by reframing the Mars migration arguments in such a way, we do not end up with a strong directive to migrate to Mars or not; rather, we treat Mars migration as an ongoing process of inquiry which will itself uncover more things to be valued. In practice, what this means is that we do not rely on preconceived notions of 'the good' or of intrinsic value; rather, the experience of Mars migration is the process by which we uncover what to value and as a guide to further action (Anderson 2019). Such an approach to ethics, I also argued, should be done democratically in order to address the patterns of injustice and exclusion that I have identified in previous chapters.

In answering my main research question, I have laid the groundwork for a more fruitful and fair debate over the question of Mars migration – one which stands a better chance of generating a morally justifiable case in favour of Mars migration.  If Mars migration does become a reality, the confluence of technological development and philosophical discourse is why I have argued for a pragmatic approach; traditional ethics may simply be unsuitable for such a dramatic and unprecedented situation. My aim in reframing the question of Mars migration with a pragmatist point of view has been to open up the debate in such a way that has greater relevance for ordinary people – the 'humanity' which is so often invoked in the Mars discussion. From a moral point of view, there are inherent problems with a technological enterprise that tends towards exclusion, and these are exacerbated by a philosophical discourse that often commits to theoretical principles ahead of time. The moral case for Mars migration requires, at the very least, a retooling of the methodological and

procedural frameworks that we use to approach the question. In this nascent field, there is little that can be taken for granted.

Words: 23,950

# REFERENCES

- (2018) *Becoming Interplanetary.* [Video] The Library of Congress. Retrieved from https://www.loc.gov/item/webcast-8553/
- Amos, J. (2011, February 14) Mars500 crew 'walk on Mars' on simulated mission. *BBC News*. https://www.bbc.com/news/science-environment-12446405
- Amos, J. (2017, May 31) SpaceX NASA Mission: Astronauts on historic mission enter space station. BBC News. Retrieved from https://www.bbc.com/news/science-environment-52867494
- Anderegg, W. R., Prall, J. W., Harold, J., & Schneider, S. H. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences*, *107*(27), 12107-12109.
- Andersen, R. (2014). Exodus: Elon Musk argues that we must put a million people on Mars if we are to ensure that humanity has a future. *Aeon Magazine*. Retrieved from https://aeon.co/essays/elon-musk-puts-his-case-for-a-multi-planet-civilisation
- Anderson, E. (2019) "Dewey's Moral Philosophy", The Stanford Encyclopedia of Philosophy Edward N. Zalta (ed.). Retrieved from https://plato.stanford.edu/archives/win2019/entries/dewey-moral/.
- "An unconference on Mars" (n.d) *Decolonizing Mars.* Retrieved from https://www.decolonizemars.org/motivation
- Bainbridge, W. S. (2007). Converging technologies and human destiny. *The Journal of medicine and philosophy*, *32*(3), 197-216.
- Beauchamp, T. L. & Childress, J. F. (2013). *Principles of biomedical ethics*. New York. Oxford University Press.
- Beckman, L., & Rosenberg, J. H. (2018). Freedom as Non-domination and Democratic Inclusion. *Res Publica*, *24*(2), 181-198.
- Billings, L. (2019). Colonizing other planets is a bad idea. *Futures*, *110*, 44-46.
- Blackburn, S. (2005). *The Oxford dictionary of philosophy*. OUP Oxford.
- Bostrom, N. (2011). Existential risk prevention as the most important task for humanity. Faculty of Philosophy & Oxford Martin School University of Oxford.
- Brabaw, K. (2019, January 07) From Radiation to Isolation: 5 Big Risks for Mars Astronauts (Videos). *Space.* Retrieved from https://www.space.com/42918-big-space-risks-mars-astronauts-videos.html
- Lewis, C.T. & Short, C. (1879). *A Latin Dictionary*. Oxford University Press.
- Chu, J. (2014, September 18) Shrink-wrapping spacesuits. Spacesuits of the future may resemble a streamlined second skin. *MIT News.* Retrieved from https://news.mit.edu/2014/second-skin-spacesuits-0918
- Chyba, C. F. (2000). Energy for microbial life on Europa. Nature, 403(6768), 381-382.
- "Colonization" (2009) In *Oxford English Dictionary Second Edition on CD-ROM (v. 4.0)*. Oxford University Press.
- Crutzen, P. J. (2006). The "anthropocene". In T. Krafft (Ed.) *Earth system science in the anthropocene* (13-18). Springer, Berlin, Heidelberg.
- Cockell, C. S. (2007). *Space on earth: Saving our world by seeking others*. Palgrave Macmillan.
- Davenport, C. (2018). *The space barons: Elon Musk, Jeff Bezos, and the quest to colonize the cosmos*. [Audible audiobook] Narrated by Will Collyer. PublicAffairs. Retrieved from https://www.amazon.co.uk/Space-Barons-Bezos-Colonize-Cosmos/dp/1610398297/ref=sr_1_1?crid=3OX7NSBOPZ5B5&dchild=1&keywords=the+space+barons&qid=1603719020&sprefix=Space+Barons+%2Caps%2C154&sr=8-1
- Davies, P. (2004) 'Life (and Death) on Mars'. *New York Times*. Retrieved from http://www.nytimes.com/2004/01/15/opinion/life-and-death-on-mars.html.

- De Haan, I. (1993). *Zelfbestuur en staatsbeheer: het politieke debat over burgerschap en rechtsstaat in de twintigste eeuw*. Amsterdam. Amsterdam University Press.
- Dewey, J. (1916) Democracy and Education. In *The Middle Works, 1899-1924* (Vol. 13) (1976). Carbondale. Southern Illinois University Press
- Dewey, J. (1922) Valuation and Experimental Knowledge. In *The Middle Works*, 1899–1924, (Vol. 13) (1976), J. A. Boydston (ed.), Carbondale. Southern Illinois University Press.
- Dewey, J. (1922). Human nature and conduct. In *The Middle Works*, 1899–1924, (Vol. 13) (1976), J. A. Boydston (ed.), Carbondale. Southern Illinois University Press.
- Dewey, J. (1925). Value, objective reference and criticism. In *The Later Works, 1925 – 1953,* (1981) J. A. Boydston (ed.), Carbondale. Southern Illinois University Press
- Dewey, J. (1925a), *Experience and Nature*. Chicago. Open Court Publishing.
- Dewey, J. (1927) The Public and Its Problems. In *The Later Works, 1925 – 1953,* (1981) J. A. Boydston (ed.), Carbondale. Southern Illinois University Press
- *Dewey, J. (1939) Theory of Valuation.* In *The Later Works, 1925 – 1953,* (1981) J. A. Boydston (ed.), Carbondale. Southern Illinois University Press
- Dewey, J. (1940). Creative democracy: The task before us. New York. GP Putnam's Sons.
- Dewey, J. (1957). Reconstruction in philosophy (No. 48). Beacon Press.
- Drake, N. (2018 November 9) We need to change the way we talk about space exploration. *National Geographic.* Retrieved from https://www.nationalgeographic.com/science/2018/11/we-need-to-change-way-we-talk-about-space-exploration-mars/
- Feltman, R. (2017, September 27). Check out the United Arab Emirates' plans for building a Martian city – right here on Earth. *Popular Science.* Retrieved from https://www.popsci.com/united-arab-emirates-mars-city-pictures/
- Fisher, J. (2006). Pragmatic conceptual analysis. (Doctoral dissertation). University of Arizona.
- Fisher, J. C. (2014). Meanings and methodologies. In *New Waves in Philosophy of Mind*, 54-76. Palgrave Macmillan, London.
- Fogg, M. (1995). *Terraforming. Engineering Planetary Environments.* Warrendale, PA: SAE International, (260).
- Franz, H. B., Trainer, M. G., Malespin, C. A., Mahaffy, P. R., Atreya, S. K., Becker, R. H., ... & Manning, H. L. (2017). Initial SAM calibration gas experiments on Mars: Quadrupole mass spectrometer results and implications. *Planetary and Space Science*, 138, 44-54.
- Goodin, R. E. (2016). On settling. Princeton University Press.
- Gottlieb, J. (2019). Space colonization and existential risk. Journal of the American Philosophical Association, 5(3), 306-320.
- Green, B. P. (2019). Self-preservation should be humankind's first ethical priority and therefore rapid space settlement is necessary. *Futures*, 110, 35-37.
- Griggs, M. B (2017 September 29) All the countries (and companies) trying to get to Mars. *Popular Science*. Retrieved from https://www.popsci.com/who-wants-to-go-to-mars/
- Haslanger, S. (2005). What are we talking about? The semantics and politics of social kinds. *Hypatia*, *20*(4), 10-26.
- Haskins, C. (2018 August 14) The racist language of space exploration. *The Outline.* Retrieved from https://theoutline.com/post/5809/the-racist-language-of-space-exploration?zd=1&zi=cxavcc5d
- Henry, C. (2017, March 30) SpaceX demonstrates rocket reusability with SES-10 launch and booster landing. *Space News.* Retrieved from https://spacenews.com/spacex-demonstrates-rocket-reusability-with-ses-10-launch-and-booster-landing/
- Hickman, L. A. (1990). *John Dewey's pragmatic technology*. Indiana University Press.

- Highfield, R. (2006, December 1) We Must Leave Earth, Says Hawking. *The Telegraph*. Retrieved from http: //www.telegraph.co.uk/news/uknews/1535661/We-must-leave-Earth-says-Hawking.html.
- Hildebrand, D. (2018). John Dewey. *The Stanford Encyclopedia of Philosophy* (Winter 2018 Edition), Edward N. Zalta (ed.), Retrieved from https://plato.stanford.edu/archives/win2018/entries/dewey/.
- "human migration" (2020, May 19) *Encyclopedia Britannica.* Retrieved from https://www.britannica.com/topic/human-migration
- Johnson, A. R. (2019). Biodiversity requirements for self-sustaining space colonies. *Futures*, *110*, 24-27.
- "Journey to Mars: Pioneering Next Steps in Space Exploration" (2018, December 24) *NASA.* Retrieved from https://www.nasa.gov/johnson/exploration/overview
- Keulartz, J., Korthals, M., Schermer, M., & Swierstra, T. (2002). Ethics in a technological culture. In *Pragmatist ethics for a technological culture*, 3-21, Springer, Dordrecht.
- Kohn, M. & Kavita, R. (2017) Colonialism. *The Stanford Encyclopedia of Philosophy.* (Fall 2017 Edition) Edward N. Zalta (ed.) Retrieved from https://plato.stanford.edu/entries/colonialism/
- Kluger, J. (2019, July 31) NASA is working with private companies to go back to the moon. That's riskier than it seems. *Time*. Retrieved from https://time.com/5639998/nasa-moon-commercial/
- Larry, A., & Moore, M. (2016). Deontological ethics. *The Stanford Encyclopedia of Philosophy* (Winter, 2016 Edition), Edward N. Zalta (ed.). Retrieved from https://seop.illc.uva.nl/entries/ethics-deontological/
- Laurini, K., Piedboeuf, J. C., Schade, B., Matsumoto, K., Spiero, F., & Lorenzoni, A. (2018). The Global Exploration Roadmap. *IAC-11 B*, *3*.
- Legg, C. and Hookway, C. (2020) Pragmatism. *The Stanford Encyclopedia of Philosophy.* In Edward N. Zalta (ed.) *Retrieved from* https://plato.stanford.edu/archives/fall2020/entries/pragmatism/.
- Madigan, T. (2009) Dewey and Darwin. *Philosophy Now.* Retrieved from https://philosophynow.org/issues/71/Dewey_and_Darwin
- Marino, L. (2019) Humanity is not prepared to colonize Mars. *Futures.* 110, 15-18.
- Marshall, A. (1993). Ethics and the extraterrestrial environment. Journal of applied philosophy, 10(2), 227-236.
- Mersmann, K. (2015 September 18) The Fact and Fiction of Martian Dust Storms. *NASA.* Retrieved from https://www.nasa.gov/feature/goddard/the-fact-and-fiction-of-martian-dust-storms
- McKay, C. P. (1997). The search for life on Mars. In *Planetary and Interstellar Processes Relevant to the Origins of Life*, 263-289. Springer, Dordrecht.
- McKay, C. P. (2011). The search for life in our Solar System and the implications for science and society. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369(1936), 594-606.
- Miller, J.D (2014) Mars of Science, Mars of Dreams in Hendrix, H. V., Slusser, G., & Rabkin, E. S. (Eds.) *Visions of Mars: Essays on the Red Planet in Fiction and Science*. McFarland.
- Milligan, T. (2016). Space ethics without foundations. In *The Ethics of Space Exploration*, 125-134. Springer, Cham.
- Munévar, G. (2014) 'Space Exploration and Human Survival'. Space Policy, 30, 197– 201
- Munevar, G. (2019). An obligation to colonize outer space. Futures, 110, 38-40.
- Musk, E. (2017) 'Making Humans a Multi-Planetary Species'. New Space, 5, 46–61
- O'Callaghan, J. (2019 February 11) Goodbye Mars One, The Fake Mission to Mars That Fooled the World. *Forbes*. Retrieved from

https://www.forbes.com/sites/jonathanocallaghan/2019/02/11/goodbye-mars-one-the-fake-mission-to-mars-that-fooled-the-world/#2a8855372af5

- Ogbunu, C. Brandon (2020 July 15) How Afrofuturism Can Help the World Mend. *Wired*. Retrieved from https://www.wired.com/story/how-afrofuturism-can-help-the-world-mend/
- O'Neill, G. K. (1977). *The high frontier: Human colonies in space*. William Morrow and Company
- Onofri, S. (2011). Colonization (Biological). In M. Gargaud, R. Amils, J. C. Quintanilla, H. J. (Jim) (eds) Encyclopedia of Astrobiology. Springer, Berlin, Heidelberg. Retrieved from https://link.springer.com/referenceworkentry/10.1007%2F978-3-642-11274-4_144
- People's Daily Online (2006 July 20) Roundup: China to develop space exploration in five years. Retrieved from http://en.people.cn/200607/20/eng20060720_284801.html
- Petranek, S. (2015). *How we'll live on Mars*. [Audible audiobook] Narrated by Stephen Petranek. Simon and Schuster. Retrieved from https://www.audible.co.uk/pd/How-Well-Live-on-Mars-Audiobook/B00ZQK7JMQ?qid=1603435458&sr=1-1&ref=a_search_c3_lProduct_1_1&pf_rd_p=c6e316b8-14da-418d-8f91-b3cad83c5183&pf_rd_r=M65CTGDN3NTPRZTR5TRZ
- Pettit, P. (2014). *Just Freedom: A Moral Compass for a Complex World* (Norton Global Ethics Series). WW Norton & Company.
- "populate." (n.d.) *American Heritage® Dictionary of the English Language, Fifth Edition*. (2011). Retrieved from https://www.thefreedictionary.com/populate
- Robinson, S. & Vath, C. (2015) Minimum viable population. *Britannica.* Retrieved from https://www.britannica.com/science/minimum-viable-population
- Rockman, M., & Steele, J. (Eds.). (2003). *Colonization of unfamiliar landscapes: the archaeology of adaptation.* Psychology Press.
- Ross, D., & Ross, W. D. (2002). *The right and the good*. Oxford University Press.
- Russel, A. & Vinsel, L. (2017, February 1) Whitey on Mars. Elon Musk and the rise of Silicon Valley's strange trickle-down science. *Aeon*. Retrieved from https://aeon.co/essays/is-a-mission-to-mars-morally-defensible-given-todays-real-needs
- Sagan, C. (1994) *Pale Blue Dot: A Vision of the Human Future in Space*. New York. Random House.
- Sand, M. (2019). On "not having a future". *Futures*, *107*, 98-106.
- "settlement" (n.d) In *Lexico.* Retrieved from https://www.lexico.com/definition/settlement
- Schulte, P., Alegret, L., Arenillas, I., Arz, J. A., Barton, P. J., Bown, P. R., ... & Collins, G. S. (2010). The Chicxulub asteroid impact and mass extinction at the Cretaceous-Paleogene boundary. Science, 327(5970), 1214-1218.
- Schwartz, J. S. (2020). The Accessible Universe: On the Choice to Require Bodily Modification for Space Exploration. In Szocik, K. (Eds.), *Human Enhancements for Space Missions*, 201-215. Springer, Cham.
- Sharp, L. A. (2002). *The sacrificed generation: Youth, history, and the colonized mind in Madagascar*. Univ of California Press.
- Sharp, T. (2017, December 15) How Far Away is Mars? *Space*. Retrieved from https://www.space.com/16875-how-far-away-is-mars.html
- Sheetz, M. (2020 August 18) SpaceX pushes reusing rockets further with record sixth landing of a single booster. *CNBC*. Retrieved from https://www.cnbc.com/2020/08/18/spacex-reuses-and-lands-falcon-9-rocket-booster-for-record-6th-time.html#:~:text=To%20date%2C%20SpaceX%20has%20landed,used%20boosters%20for%2040%20missions.&text=Tech-,SpaceX's%20current%20fleet%20of%20rockets%20are%20partially%20reusable%2C%20with%20the,of%20the%20nosecone%20after%20launches.
- Slobodian, R. E. (2015). Selling space colonization and immortality: A psychosocial, anthropological critique of the rush to colonize Mars. Acta Astronautica, 113, 89-104.

- Smith, K. C., Abney, K., Anderson, G., Billings, L., Devito, C. L., Green, B. P., ... & Potthast, A. (2019). The Great Colonization Debate. *Futures*, *110*, 4-14.
- SpaceX. (n.d) *About SpaceX*. Retrieved from www.spacex.com/about
- Specktor, B. (2018, May 30) The unique challenges of human reproduction on Mars. *Real Clear Science.* Retrieved from https://www.realclearscience.com/articles/2018/05/30/the_unique_challenges_of_human_reproduction_on_mars_110658.html
- "Starship service to Earth orbit, Moon, Mars and Beyond" (2020) *SpaceX.* Retrieved from https://www.spacex.com/vehicles/starship/
- Stockton, N. (2016, September 27) Elon Musk Announces His Plan to Colonize Mars and Save Humanity. *Wired*. Retrieved from https://www.wired.com/2016/09/elon-musk-colonize-mars/
- Stone, D., Lindenmoyer, A., French, G., Musk, E., Gump, D., Kathuria, C., ... & Pickens, T. (2008). NASA's approach to commercial cargo and crew transportation. Acta Astronautica, 63(1-4), 192-197.
- Stoner, I. (2017). Humans should not colonize mars. *Journal of the American Philosophical Association*, 3(3), 334-353.
- Strong, M. T., & Chaplin, K. S. (2019). afrofuturism and black panther. *Contexts*, *18*(2), 58-59.
- Swierstra, T. (2002). Moral Vocabularies and Public Debate. In *Pragmatist ethics for a technological culture*, 223-240. Springer. Dordrecht.
- Talisse, R. B., & Aikin, S. F. (2008). *Pragmatism: a guide for the perplexed*. A&C Black.
- Traphagan, J. W. (2019). Which humanity would space colonization save?.*Futures*, *110*, 47-49.
- United States. National Aeronautics and Space Administration. (2015). *NASA's Journey to Mars: Pioneering Next Steps in Space Exploration*. National Aeronautics and Space Administration.
- Vance, A. (2015). *Elon Musk*. [Audible Audiobook] Narrated by Fred Sanders. Harper Collins. Retrieved from https://www.audible.co.uk/pd/Elon-Musk-Audiobook/B079TLY6HS?qid=1605722382&sr=1-1&ref=a_search_c3_lProduct_1_1&pf_rd_p=c6e316b8-14da-418d-8f91-b3cad83c5183&pf_rd_r=5QPAR0VTMG2TQ9APDEYT
- Wall, M. (2019, December 17) If we find life on Europa or Enceladus, it will probably be a '2nd Genesis'. *Space.* Retrieved from https://www.space.com/alien-life-europa-enceladus-second-genesis.html
- Wamelink, G. W., Frissel, J. Y., Krijnen, W. H., Verwoert, M. R., & Goedhart, P. W. (2014). Can plants grow on Mars and the moon: a growth experiment on Mars and moon soil simulants. PLoS One, 9(8).
- "Welcome back and thank you, Mars500" (2011 November 4) *The European Space Agency*. Retrieved from https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Mars500/Welcome_back_and_thank_you_Mars500
- Wells-Jensen, S., Miele, J. A., & Bohney, B. (2019). An alternate vision for colonization. *Futures*, *110*, 50-53.
- Wenar, L. (2011). Poverty is no pond: challenges for the affluent. In Illingworth, P., Pogge, T., & Wenar, L. (Eds.). *Giving well: The ethics of philanthropy*. OUP USA.
- "What is Surface Operations?" (n.d) Mars 2020 Mission Perseverance Rover. Retrieved from https://mars.nasa.gov/mars2020/timeline/surface-operations/
- Zimmerman, M. J. & Bradley, B. (2019) Intrinsic vs. Extrinsic Value. *The Stanford Encyclopedia of Philosophy* (Spring 2019 Edition), Edward N. Zalta (ed.), Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/spr2019/entries/value-intrinsic-extrinsic/.

- Zubrin, R. (2011). *Case for mars*. Simon and Schuster.
- Zwart, H. (2002) Philosophical Tools and Technical Solutions. In Keulartz, J., Korthals, M., Schermer, M., & Swierstra, T. (Eds). In *Pragmatist ethics for a technological culture*. 3-21. Springer, Dordrecht.