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## Planners in space?

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# planners in space?

**David Adams, Peter Larkham and Dan Sage chart the problems in contemporary aspirations for space exploration and colonisation and make a case for the imaginative potential contribution of planners to ongoing debates on human space futures**

*These notes should be read thoroughly only by an optimist!*

In *Pale Blue Dot: A Vision of the Human Future in Space*,<sup>1</sup> Carl Sagan discusses how Robert Goddard, inventor of the modern liquid-fuelled rocket, outlined his visions for space exploration in a manuscript published in 1918 called *The Last Migration* – the cover page of which carried a warning that ‘the[se] notes should be read thoroughly only by an optimist!’

For some, the human race is entering a new ‘golden era’ of space exploration, driven in part by enthusiastic super-rich space entrepreneurs keen to wrestle control from government space agencies, following years of perceived inertia.<sup>2</sup> Such enthusiasm has also helped to reinvigorate public and government interest in the potential scientific, educational, commercial and strategic benefits that a ‘new’ space race may bring. And prominent figures such as Elon Musk, Tesla and SpaceX CEO, Jeff Bezos, founder of Blue Origin and Amazon, and Sir Richard Branson, founder of Virgin Galactic, together with other space advocates, are pursuing bold, imaginative ideas for space tourism and asteroid mining.

Beyond mass space travel, space mining and manufacturing, though, Elon Musk and others harbour much broader dreams of space exploration, and plans are in place for the colonisation of the Moon and Mars, a step some believe necessary for the survival and evolution of humanity. Furthermore, the Kepler telescope and teams of enthusiastic Earth-bound astronomers have discovered over 4,000 Earth-sized planets orbiting other stars in the Milky Way.<sup>3</sup>

These discoveries – alongside Yuri Milner’s recent Breakthrough Listen initiative, an astronomical search for evidence of intelligent life beyond Earth, and his Breakthrough Starshot, a space probe that could travel to another star – have also helped stir public curiosity about the imaginative possibilities

of space and have spurred speculation that celestial bodies might host signs of life.<sup>4</sup>

Debates about the scientific, economic, engineering and technological possibilities and challenges of a greater human presence in space continue to mature. However, there are also claims that space exploration offers an opportunity to ‘remake’ urbanism to suit new off-Earth worlds, and on our own ‘ecologically changing planet’.<sup>5</sup> But these claims are set against a background of broader concerns that planners and other social scientists should ‘look up’ and contribute more to debates on possible space futures.

Confident pronouncements about the future are dangerous, and there are fears that thinking through outlandish visions of the future succeeds only in extending conventional wisdom to a point of absurdity. Nevertheless, the views of someone as scientifically respected and as integrated into popular culture as Stephen Hawking, who championed ‘thinking the unthinkable’ and was unafraid of big challenges and long-time frames,<sup>6</sup> chime with recent calls from planners to think creatively about planning for a long-term future.<sup>7</sup>

Of course, behind these exciting possibilities lie problems associated with the philosophical arguments underpinning the need for a greater human presence in space, and the economic and practical difficulties of ‘new’ space. This article briefly explores some of these problems before making the case for why planning enquiry into space exploration and colonisation is relevant – first, planners may be able to play a very practical role in the appraisal of current and future settlement proposals; and, second, planners have an opportunity to investigate new, creative ‘horizons of meaning’ about what might emerge in the future.<sup>7</sup> It then reflects on the robustness of existing planning theories, concepts and practical endeavours.

## Wander and thrive?

In his review of the putative shifts in the motivations of space supporters, Gary Westfahl,<sup>8</sup> the well known commentator on popular science, highlighted how many organisations, popular science communicators and authors of science fiction advance the philosophical argument that humankind must venture into and inhabit outer space to satisfy a basic human ambition to explore and occupy unfamiliar worlds. Carl Sagan<sup>9</sup> saw this impulse as being a central part of human behaviour and an innate instinct: he pointed out that 'travel is broadening', and, like our ancient ancestors, 'we are haltingly, tentatively breaking the shackles of Earth'. For Sagan, human space travel is necessary to escape not only the constraints of our 'primitive brains',<sup>9</sup> but also humankind's desire for territoriality – a yearning which eventually became synonymous with statecraft, ethnocentrism, unequal hierarchies of power, and subordination.<sup>10</sup>

Of course, it is extremely difficult to trace the different forces that led to each individual example of early human migration, given the relative paucity of the historical/archaeological record. Nevertheless, recent anthropological perspectives of surviving hunter-gatherer societies suggest that earlier societies managed to maintain strong commitments to their local ancestral landscape, even when faced with a rapidly changing contemporary world<sup>11</sup> – and that climate change, natural disasters, struggles with aggressive neighbouring groups, depletion of resources within an area, or the movement of more mobile herds of herbivores shaped the decisions of our forebears to migrate from a settled environment to new, unfamiliar and possibly hostile places.<sup>11</sup>

Although people have tried to control and alter their environment, experiments in farming also meant that dairying farmers, for example, had an advantage over hunter-gathers, in that they could better weather different threats.<sup>12</sup> It is conceivable,



**A trio of space entrepreneurs – from left to right, Elon Musk, Jeff Bezos and Yuri Milner**

*Courtesy of Jonathan Cusick*

Westfahl, though, pointed out potential flaws in Sagan's hypothesis of how a certain inertia set in following the end of the great human migrations, some 10,000 years ago.<sup>8</sup> The implication here, for Sagan at least, was that hunting and gathering are inspiring activities, while agriculture, animal husbandry, and settlement creation are enervating pursuits; a sedentary life has made humans edgy and unfulfilled.<sup>1</sup>

Nevertheless, as Westfahl suggested, considerable human resourcefulness is also needed to irrigate, fertilise, harvest and store crops, breed animals and develop tools for the efficient cultivation of land.<sup>8</sup> Once settled, the foundations of civilisation – means of shelter, economic exchange and labour relations, artisanship, record-keeping, written language, communication, education, and systems of government – take root.

therefore, that wanderers and invaders of distant lands needed more than energy and vitality to thrive: they also required some 'sense of permanence', a relatively stable place from which to reflect on the past and look to the future.<sup>13</sup>

And although there are many positive representations detailing human encounters with space, there are understandable concerns about being cut off from friends, relatives and the places that people value. Indeed, some interpret the messages conveyed by popular contemporary science communicators as pushing an overly scientific worldview; a powerful perspective which emphasises Earth's role in the wider cosmos, but one that downplays the creative power of human intentions and underappreciates the rich, varied temporal links humans have with their surroundings.<sup>14</sup>

Settlements inevitably can grow, shrink or adapt because of the processes and motivations of different actors. Yet settlements, and the buildings, structures and monuments they contain, become centres of meaning, reaching back beyond the indelible impressions of our own past to the shared memories of earlier generations; in a way, they lie beyond the cosmic order of things, as humans impose their own meanings, values and forms on the environment. And large urban centres, despite their many apparent failings, remain important sites for ideas, culture, employment, and entertainment; crucially, of course, they are also crucibles for the theoretical and practical science embraced by supporters of space exploration.<sup>15</sup>

In short, perhaps people are less than sanguine about the idea of uprooting themselves to travel great distances, especially in the absence of urgent and terrible problems that require mass travel into space.

Space advocates would counter this argument with the claim that a move away from Earth, led by visionary and brave humans channelling their impulse to venture into the unknown, is necessary to avoid future economic, social and cultural stagnation and environmental problems – many of which are urban in nature – and to move humanity forward. And many fictional and non-fictional accounts develop this theme when discussing the merits of space habitats.

The renowned physicist and futurist Michio Kaku<sup>3</sup> provided a recent iteration of this view when he suggested that a small number of visionaries, when armed with pioneering technology, will help to ensure that humankind reaches its destiny of living among the stars. Similarly, Bezos claims that becoming a space-faring civilisation is the next logical step for human society.<sup>16</sup> For some potential space pioneers, the reasons for wanting to venture beyond Earth's limit reveal a historical desire to explore new worlds, blended with a desire to inspire new generations and unearth unexpected scientific and economic discoveries. In part, these desires are reflected in the testimonies of the 100 potential colonisers of the Mars One initiative – an ambitious, although occasionally criticised, project designed to create a human settlement on Mars.<sup>17</sup>

While Bezos and Musk strongly argue that the future of humankind lies in space colonisation, their visions are also rooted in a future past, albeit one founded in free-market economics and made possible by technological advances. For example, Bezos believes that the way to protect Earth is by moving heavy industry – a vestige of an earlier industrial age – into space, while Earth returns to a pristine patchwork of cities, parks and wilderness.<sup>18</sup> Musk, however, in looking to launch a Mars-bound crew as early as the mid-2020s, plans to pave the way for the large-scale and affordable movement

of people to settle in a thriving 'self-sustaining' frontier city; one that could grow to house a million individuals within a few decades.<sup>19</sup>

In both cases, human progress (in space) involves a resetting of the historical dial to a time before the growth of overcrowded, polluting, congested urban areas which put a limit on human imaginings. Space exploration offers a chance to recapture a sense of industriousness before bureaucrats, technocrats, planners and other institutionalists failed in their late-20th century efforts to chart a clear path to the (space) future.<sup>20</sup>

In other ways, though, there is a curious logic to the innate desire to travel, especially given that diverse groups, societies and individuals have distinct ideas about wanderlust. Despite the seemingly innumerable contemporary and near-future Earth-based concerns (see below), the sheer incalculability of space travel might stir deep-rooted psychological anxieties about the prospect of inhabiting an unfamiliar realm lying far beyond the comfort of home.

While some space advocates look to embrace the industrial potential of space exploration as a way of escaping or rectifying Earth-based problems, critics point out that future human presence in space stands for a continuation of a pernicious form of liberal democratic market capitalism, or an extension of neo-colonial, fantasist, and largely masculine posturing<sup>21</sup> – too much focus on space is an unhelpful and unpalatable diversion from developing alternative post-capitalist futures. Yet the perspectives of space advocates and those critical scholars' views are perhaps guilty of foreclosing the 'transcendental' possibilities of space,<sup>22</sup> by focusing on what a (relatively) recent past has taught us. These views potentially close off other imaginatively conceived plans, potential forms of sociality and exchange values that may act as an inspiration for different audiences.<sup>20</sup>

### **Commencing countdown, engines on**

Countless fictional and non-fictional accounts set out in rich detail the bountiful opportunities of space exploration in terms of the potential growth and expansion of markets, societies, resource extraction, and product development.<sup>23</sup> There are obvious and well rehearsed objections to these laudable ambitions.

Some argue that they remain a specialist, technical pursuit, where small numbers of high-cost, high-risk missions leave Earth in the service of science, prestige and capital.<sup>21</sup> Then there are questions about the difficult, dangerous nature of space travel and dealing with radiation levels, and arguments that spacecraft and settlements need to provide ambient temperatures, acceptable pressures and breathable air; that rockets may have high failure rates; that humans need considerable time to prepare for

arduous journeys in space; that creating space habitats – the terraforming of new ‘worlds’ – will be slow and costly; and that vast engineering schemes on the Moon, Mars or other planets would be invasive.

Furthermore, the prospect of wider expansion of space activity might meet considerable political, economic, social and/or environmental objection. And although space may provide a more suitable environment for testing new concepts than we have here on Earth, the profits from some of the more audacious space proposals may not materialise for some time. By then, human ingenuity may well have developed terrestrial solutions to problems, and/or machines may be able to create an almost perfect vacuum and mirror some of the effects of low gravity. Future markets for materials may change, making space resources less financially attractive, and the ambitions and investment plans of space promoters may alter, too.

Despite these apparently insuperable criticisms, the ‘growing edge’ of science continues to advance. It is widely known that satellite telecommunications, global positioning systems and developments in weather forecasting, enhanced international collaborations and innovation are all indicators of successful space endeavours. Since the Apollo missions of the 1960s and early 1970s, the human spaceflight programme has focused on low-Earth orbit and the International Space Station. However, the European Space Agency plans to establish an international ‘MoonVillage’ inhabited by researchers, miners, entrepreneurs, and tourists.<sup>24</sup> Both China and Russia also see importance of having a presence on the Moon, while NASA and other advocates of the International Space Exploration Coordination Group see cis-lunar space and the lunar surface as potential testing grounds for systems and practices in readiness for human missions to Mars after 2030.<sup>2</sup> Science and prestige are potentially strong motivators at a time when world leaders are looking to make strategic advances.

Moreover, private companies may beat NASA in the race to the ‘red planet’. For example, with sustained financial backing and support, Mars One is seeking to send a first crew of four courageous explorers on a one-way mission to set up a permanent settlement by 2035.<sup>25</sup> And Musk’s recently unveiled ‘Interplanetary Transport System’ (ITS), with improved, retro-propulsion systems and re-usable rockets, would significantly increase the US spaceflight capacity and pave a way for the colonisation of Mars.<sup>26</sup> There are also serious discussions about innovative space launches, new rocket fuels and propulsion systems, while increased production of graphene could create larger, lighter, safer and cheaper rockets.<sup>2</sup>

If these developments emerge in the near future, some predict that personal access to space will begin to fall within the ambit of a substantial

fraction of the global middle-class population.<sup>27</sup> Innovative space companies, some backed by venture capital, are already working on building and launching cheaper, smaller satellites, that will not only deliver valuable ‘big data’ for telecommunications, logistics, agriculture and retail sectors, but will also bring advantages to environmental monitoring.<sup>28</sup>

Elsewhere, there has already been considerable international debate over whether national or international space laws should govern the mining of outer space, given that the United States and Luxembourg recently passed legislation giving

## **‘With these developments in mind the constraints of plausibility begin to loosen; proposals for a greater human engagement with space become increasingly grounded in the familiar’**

companies the rights to the space resources they extract.<sup>29</sup> Companies are already relying on that legal authority to attract investment for their plans to mine the Moon and asteroids. In the US, the two companies at the forefront of this endeavour – Planetary Resources, and Deep Space Industries – not only plan to extract precious metal and minerals, but also to mine water and convert it into liquid hydrogen and liquid oxygen, which are used as rocket fuel and oxidiser.<sup>30</sup> This would allow the creation of strategically placed, in-space fuel depots, thus allowing deeper exploration of space, as it would reduce the amount of fuel needed to launch rockets from Earth.

Moreover, in the US, the recently passed ‘Space Resources Utilization and Exploitation Act’<sup>31</sup> specifies that extraction of abiotic material (water and minerals, for example) in outer space is allowed, but less clear is whether commercial companies or citizens could recover and retain *biotic* material (microbial life). If this were to happen, it would have potentially immeasurable value and act as a stimulus for profiteering.<sup>26</sup>

With these developments in mind, therefore, the constraints of plausibility begin to loosen; proposals for a greater human engagement with space become increasingly grounded in the familiar.

### **Taking cover in a cosmic shooting gallery**

In some ways, and despite the technical advances sketched out above, the general mood of the age is one of grim forebodings of Earthly disasters. Popular media outlets, in the Global North at least, carry stories of an impending economic or

environmental collapse, of inequality, and oceans choked with plastic. Environmentalists stress the pressing need to resolve problems of anthropogenic climate change, resource depletion, the dangers of over-population, the limits to growth in an increasingly urbanised world, and the possibility of accelerated species extinction. Extreme religious groups want a return to a mythological age of purity and divinity. There are fears about ongoing political instability in parts of the world, and over the swagger of belligerent political leaders sitting on a stockpile of nuclear arms. Science and technology are associated with some of these problems.

For others, though, contemporary advances in scientific methods of observation, experiment and measurement, made more discerning by developments in technology, promise to 'lift us out of the parochial fog' enveloping the world below.<sup>32</sup> Or, as the leading astrophysicist and popular science communicator Neil deGrasse Tyson put it, a cosmic perspective – founded on an unshakeable belief in universality of physical laws – will help bring about much-needed values of environmentalism and global kinship at a time when Earth faces innumerable 'natural' and human-induced catastrophes.<sup>33</sup>

Science tells us that humanity faces the unsettling prospect of a new ice age, a super volcano, and another meteor or asteroid strike, similar to the one that helped to seal the fate of the dinosaurs some 65 million years ago.<sup>3</sup> There is also the disquieting possibility of increased militarisation of space, and the possibility that increasing numbers of (expensive) satellites and other debris orbiting Earth will collide; this would seriously hinder ambitions of creating more space-conquering technologies of communication and potentially restrict plans for a greater human presence in space. Proposals from companies like Planetary Resources would require considerable launch infrastructure, increasing the chances of more space debris, while ideas for in-space fuel depots and Musk's ambitions for an ITS would also need to be scrutinised for safety and reliability.

If public anxiety over these and other threats grow, we can expect increasingly explicit arguments about the need for forceful state and commercial space ambitions designed to respond to future dangers.

Unsettling accounts, films and other broadcasts of errant asteroids, the chance of space wars, and dealing with recalcitrant space debris all also chime with earlier arguments that investments in space are necessary to stifle feelings of paranoia, or even embarrassment, about dangerous 'alien' antagonists.<sup>34</sup> The effects of an asteroid collision or nuclear devastation would certainly be disastrous – millions of immediate deaths, and many more lives lost from the later effects. And yet, while it would not be pleasant to live in parts of the world affected

by an asteroid strike, it is also likely that enough people would survive to keep humanity in existence.

However, there is an argument shared by many – irrespective of individual political or ideological position – that humankind has a duty to ensure that life on Earth does not come to some unfortunate, premature end. So, although these unpalatable scenarios may remain a remote statistical possibility, they also contain a certain motivational force, acting as an incentive to steer future decisions, including the actions of those involved with planning, designing and delivering 'resilient' places.

### **Crossing the sea of night**

If there are flaws in the three areas set out above, this section outlines some stronger arguments over where planners might contribute to ongoing debates on human space futures.

First, although existential fears of near-future large-scale destruction may be over-exaggerated, there is little doubt that at some point, eventually, Earth will no longer be able to support human life, so our descendants will have to live elsewhere – spaceports, planets, moons, Dyson spheres – if the human race is to survive. Some may take the view that if this occurs soon – because of the threat of nuclear war, disease, climate change, errant asteroids or anything else – humanity is condemned in any event, given that any planetary outpost, even one with excellent lines of communications, could not survive or thrive without regular, sustained support from Earth. Others might argue that if this event does not occur until further in the future, there is enough time to develop imaginative, implementable plans.

But where do we begin, given the limitations outlined in the preceding section?

Writing some 40 years ago and against a background of the 'limits to growth' debate of the 1970s, Millward called for geographers, planners and other social scientists to explore seriously the possibility of moving to off-Earth space settlements.<sup>35</sup> Although there is now a growing social science perspective on the possibilities and limits of future space visions, there are further opportunities for planners, geographers, architects and others involved with the design and management of places to respond to these debates, assimilating them into existing approaches, or creating new research areas specifically relating to the space 'frontier'.

One practical suggestion is that planners and geographers – perhaps working alongside engineers and architects – might study the feasibility of designing new Earth-based space launch megastructures. This would involve working through the possibility of improved space launches, including the impact on the surrounding population and environment, the proximity to major industrial and

population centres, and the capability of existing power networks.

Moreover, and considering the bleak scenarios outlined above, there are obvious parallels with how architect-planners, engineers, politicians, industrialists and leading scientists saw the urgent need to rebuild as an opportunity to reform or improve cities that before the Second World War had been suffering from different urban ailments.<sup>36</sup> Infused by the image of a *tabula rasa*, the prospect of large-scale rebuilding offered the possibility to architect-planners to transform war-damaged cities and project their sometimes-radical visions of future cities.

Discussions around possible space futures could, for example, unpick the way in which the sometimes-lavish mid-20th century reconstruction plans offered a vehicle to boost the personal and strategic ambitions of politicians and other key decision-makers.<sup>37</sup> Are there lessons for entrepreneurial space enterprises in the way that powerful elites had to wrestle with bureaucratic frameworks, financial constraints, the peculiarities of a particular site, the availability of materials, the talent of architects, the desires of landowners, and, of course, the perspectives of inhabitants?

Some in the planning and design community are also beginning to raise concerns over recent plans for the human habitation of Mars (and exploration of space, in a more general sense). For example, some are anxious that the ambitions set out by organisations such as Mars City Design® for human habitation on the 'red planet' represent an opportunity for architects and designers to project their visions on to a 'blank slate'.<sup>5</sup>

This is a familiar story for planners. Since the mid-to-late-20th century, it has become almost commonplace to blame the 'metaphysical fancies'<sup>38</sup> of prominent white, middle-class, male experts for creating 'alien' spatial and temporal circuits of production, exchange and consumption that did much to eliminate spontaneity from urban life. Efforts to plan were from 'high and afar', informed by the empirical-analytical approaches of scientists, bureaucrats and engineers involved in the creation of large-scale rebuilding projects, and helping to realise a capitalist city in full flow.

But not *all* reconstruction plans projected capitalist visions of the future, and some reconstruction proposals were heavily idealistic but also pragmatic. The motivations among those potential space settlers will likely differ from those agencies and space advocates pushing for the creation of permanent off-Earth settlement. So exploring the 'cracks in the concrete' of earlier planning visions,<sup>7</sup> as individuals subverted 'utopian' narratives of the future urban environment to suit their own ends, might help to develop any discussion about human settlement of space.

Second, while there are flaws in the argument about the vital, innate need to travel, there is an opportunity to nurture the human desire to cultivate a sense of inquisitiveness and fulfilment. Or to paraphrase Alfred North Whitehead, 'physical wandering is important', but 'greater still is the power of [humankind's] adventures of thought' into 'uncharted seas of adventure'.<sup>39</sup>

Ancient human migration brought people into contact with different customs of various cultures,

Courtesy of NASA/Japan Aerospace Exploration Agency



**Thinking about space 'stimulates the enabling and motivational facets of the imagination' and 'offers an opportunity to review earlier planning imaginaries'**

philosophies, and political and social systems.<sup>1</sup> It is, therefore, valuable to consider these perspectives to gain further insight into our own beliefs, perspectives and actions.

Increased exploration of space would present a clear opportunity to further knowledge about the universe, which would stimulate human curiosity and potentially lead to some unpredictable social, economic and environmental discoveries, but would also help humankind to reflect on current and near-future Earth-based practices. Moreover, it is often said that people act and live out the past in the present. And planning tools such as maps, images, diagrams and future scenarios can certainly influence present and future action; but they can also shape how we think about the past.<sup>40</sup>

At some indeterminate point beyond the future horizon, people may be living in outer space and on other worlds, and since differing cultures stem in part from environmental conditions, it is possible that these individuals will be greatly different from earlier cultures, planning efforts, contexts, perceptions and attitudes. Hence, if a new age of space exploration marks our opportunity to 'start afresh', then there is the obvious possibility of examining capitalism, along with other economic models, and legal frameworks. Given that there will be long communication delays that may make Mars-Earth governance cumbersome, regulatory and administrative functions will need to hold authority over new lands, efficiently administer public policy and urban planning, and take responsibility to create a society in space – a theme much explored in popular science fiction.<sup>26</sup>

Changes to civilisation in terms of technology, culture and everyday life make a strict interpretation of history something of an unreliable guide to speculative spatial imaginaries. For instance, development in satellite technology and space probes may significantly advance our knowledge and understanding of the universe, thus limiting the need for physical human wanderings. Nevertheless, there are several fundamental questions that planners might explore regarding the purpose of the colony, the motivations of colony founders, the possible location of the settlement relative to the Earth and Sun, and the size and characteristics of the object on which colonists wish to settle.

Various academic works, popular histories, films and novels detail the why, when and how of frontier development, while the location of settlements and the links between regions are well established areas of enquiry for social scientists. In this sense, an exploration of the processes, agents and agency that create, shape and reshape urban form would help inform wider discourse on future space trajectories.<sup>41</sup> However, planners, geographers and urban historians, for example, could enrich discussions on space by drawing on earlier

research into the conditions necessary for permanent human settlement, and the economic, social and environmental contexts in which human habitation thrives or fails (i.e. the functions of defence, shelter, trade, and community).<sup>42</sup>

## **'Exploring the 'cracks in the concrete' of earlier planning visions, as individuals subverted 'utopian' narratives of the future urban environment to suit their own ends, might help to develop any discussion about human settlement of space'**

Although the design of a space colony would have to work within engineering and technological constraints, there are concerns that an eclectic mix of architectural styles would result in a 'Disney-like' settlement.<sup>5</sup> What key planning principles might guide development? Could 'established' planning concepts of visionary urbanists such as Howard and his Garden City, Burnham's view on the rebuilding of Chicago, Le Corbusier's radiant city, Frank Lloyd Wright and his suburban city, and Abercrombie and Forshaw's plans for London's city-region be brought into dialogue with emerging visions for life beyond Earth's limits?

At the micro-scale, investigation of the geometric properties of earlier urban forms would also contribute to any wider understanding of the processes shaping urban form. There are many studies of urban components (streets, blocks, plots, buildings, land uses, agriculture, public spaces, services, and infrastructure) that could inform debates about future colony design. Moreover, planners' interpretation of computational approaches and big data would also allow modelling of future off-Earth urban patterns at different spatial and temporal scales.

And, at some point in the future, following the establishment of a colony, how will the insertion of new structures or other features affect the characteristics of a settlement? How might we manage fragile 'historic' areas like the Apollo 11 landing site when there are pressures to develop?<sup>5</sup> This may stimulate a careful analysis of past examples of how to achieve the organic arrangement of the urban fabric, land uses, densities and human interactions to create a rich, diverse urban experience.

Perhaps the most enticing prospect is that any plans to colonise asteroids, planets or even stars may be led by genetically 'improved' humans,

cyborgs, or forms of artificial intelligence. This then opens up a completely new set of ways to think about planning in 'post-human' worlds.

## Conclusion

Countless others have sought to dampen some of the more excited claims made about increased human encounters with space. There is no unifying intellectual consensus around the feasibility of moving large numbers of people off Earth: there is a lack of safe, attractive, reliable and cheap modes of transport to break through Earth's atmosphere; for many, potentially world-changing space visions belong in the realm of science fiction, or are best left to the work of cosmologists, engineers, or those in the natural sciences; and many feel that any economic case and the recent wave of enthusiasm will eventually subside.

More fundamentally, the importance of these points to those in the planning community might seem a matter of debate: if there are flaws in the messages typically presented by supporters of space exploration, so what? Planning, like other social sciences, contains a vibrant and eclectic mix of different schools of thought, where competing ideas jostle for prominence. Consequently, any bold call for radical changes to research agendas that contribute more to contemporary or near-future debates about space would require significant adjustments in bureaucratic structures, the attitudes of educators, research councils, conference organisers, learned societies, and the editorial boards of prominent journals. Simply put, for many social scientists, the potential economic, environmental and human impact of space exploration remains outside the ambit of other more pressing Earthly matters.

Although the idea of focusing on space might invoke feelings of indifference, resistance or even enmity in some, this article does at least set out potential areas that may provoke interest from planners. The key message, though, besides thinking through the practical implications and possibilities of developing new launch sites, new satellites and off-Earth trade links, is that thinking about space stimulates the enabling and motivational facets of the imagination.<sup>7</sup>

This involves a mental shift away from being immersed in the present in our perceptions, perspectives and views. It certainly offers an opportunity to review earlier planning 'imaginaries', to use these ideas to set out new kinds of places beyond Earth, but also as a way of reflecting on how off-Earth innovations might benefit the ways in which planners and others approach the task of tackling some of the sustainability challenges here on Earth. There may be some truth in deGrasse Tyson's<sup>34</sup> view that 'nothing spurs cross-pollination of ideas like space exploration'; hence there is

opportunity here for imaginative planning ideas to penetrate the discussions on space that might otherwise be reserved for entrepreneurs or cosmologists. Perhaps this needs to happen before the boarding gates open...

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