Terraforming and the City

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Abstract

Science fictional depictions of cities have explored a variety of utopian and dystopian modes of habitation and control that have fed into popular imagination regarding the shape of future societies. The intersection between terraforming, the adaptation of planetary landscapes, and the interfaces for these interventions into multiple environments (the city) have accrued new resonances in the contemporary context of climate change. This paper considers the relationship between non-human nature and the city in narratives of terraforming from H.G. Wells's *The Shape of Things to Come* (1933), the American pulp sf of the 1950s, Frederick Turner's *Genesis* (1988) and Kim Stanley Robinson's *Red Mars*, *Green Mars* and *Blue Mars* (1992-1996). Exploring how the city relates to non-human nature in the form of the animal, bacteria and plants in these narratives, this paper raises questions about how the city as an interface with nature explores possible modes of habitation. What does this mean for a burgeoning sense of place that has begun to consider how such imagined habitations become spaces that are embedded in nature and thus reflect new conceptions of the human?

Keywords: urbanism, town planning, science fiction, ecology, terraforming, geoengineering,

Resumen

La representación de la ciudad en la ciencia ficción ha sido utilizada para explorar una variedad de modos de morada y control utópicos y distópicos que han alimentado la imaginación popular con respecto al aspecto de las sociedades futuras. La intersección entre la terraformación, la adaptación de paisajes planetarios, y las interfaces para estas intervenciones en múltiples ambientes (la ciudad), han acumulado nuevas resonancias en el contexto contemporáneo del cambio climático. Este artículo considera la relación entre la naturaleza no-humana y la ciudad en narrativas de terraformación desde *The Shape of Things to Come* (1933) de H.G. Wells a través de los *pulps* de ciencia ficción americanos de los años 50, *Genesis* (1988) de Frederick Turner, y las novelas *Red Mars*, *Green Mars* y *Blue Mars* (1992-1996) de Kim Stanley Robinson. Mediante la exploración de cómo la ciudad se asocia con la naturaleza no-humana en forma del animal, de bacterias y plantas en estas narrativas, este artículo sugiere preguntas sobre cómo estas interfaces con la naturaleza exploran posibles modos de morada. ¿Qué significa esto para un creciente sentido de lugar que ha comenzado a considerar cómo estas moradas imaginadas se convierten en espacios que se incrustan en la naturaleza y, por lo tanto, reflejan nuevas concepciones de lo humano?

Palabras clave: urbanismo, planificación urbana, ciencia ficción, ecología, terraformación, geoingeniería.

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> 'When it's dark you can see the lights of the cities down there on the night side. New York and London are easy. The prettiest sight, though, is the reflections of the Sun off the sea.' (Clarke 107)

So says an astronomer to science fiction (sf) writer Martin Gibson as they gaze upon the Earth in Arthur C. Clarke's novel of terraforming, *The Sands of Mars* (1951). This perspective is common in sf: similar episodes appear in works such as Ray Bradbury's *The Martian Chronicles* (1958 [1950]) and Robert A. Heinlein's *The Moon is a Harsh Mistress* (2001 [1966]). These scenes resonate with the *Apollo 8* 'Earthrise' photograph of 1968 and the *Apollo 17* 'Blue Marble' photograph of 1972, both of which became enduring symbols for the environmental movement. Such images index an association between space exploration and environmental thought that was alluded to by Buckminster Fuller's notion of Spaceship Earth in the 1960s. These compressed images capture important aspects of the sf narrative of terraforming: that the colonial planet's cities are built according to the model of Earth's future megacities. The second sentence highlights how, from the vantage of Mars, Earth's landscapes surpass for beauty those of its cities, yet those cities still exercise a capacity to generate wonder in those who gaze upon it from a distance. Nevertheless, the wonder generated by the spectacle of the illuminated city as seen from space is overshadowed by the beauty of the non-urban spaces of Earth.

Sf depictions of cities have explored a variety of utopian and dystopian modes of habitation and control that have fed into popular imagination regarding the shape of future societies. The intersection between the adaptation of planets, or terraforming, and the interfaces for these interventions into multiple environments (the city) have accrued new resonances in the contemporary context of climate change. Terraforming refers to the transformation of a planet other than Earth so that it can support earthbound life. The term was coined by Jack Williamson in his 1942 sf short story "Collision Orbit" before it was adopted in scientific discourse by such scientists as Carl Sagan (1973), James Oberg (1981) and Martyn J. Fogg (1995). Terraforming encompasses a range of technologies and approaches tailored to different planets that can be broadly classified as industrial engineering solutions[1] and what Robert H. Haynes terms an 'ecopoietic' approach that involves the fabrication of an ecosystem on another planet (1990). Ecopoiesis often relies on an initial engineering approach to create the conditions for pioneer species of bacteria and plants (algae and then lichen) to establish themselves on other planets so as to create and transform that planet's ecosystem sufficiently for successor species to be established. Terraforming can also be extended to include other engineering projects—such as dam construction, agriculture and urbanism—that have transformed Earth's environmental parameters. Indeed,

[1] Examples of such solutions include the creation of a runaway greenhouse effect on other planets, the injection of particles into the stratosphere or the construction of orbiting mirrors in space to manage a planet's albedo (surface reflectivity) and thus heat or cool the planet (solar radiation management), and various methods for carbon capture and sequestration. Oberg (1981) and Fogg (1995) assess a range of such hard engineering approaches to terraforming.

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anthropogenic climate change—the human-driven transformation of Earth's climate—can be considered an instance of terraforming Earth, or what Fogg describes as 'geoengineering.' Paul J. Crutzen and Eugene F. Stoermer's term, the 'Anthropocene,' refers to a geologic period which they date from the industrial revolution, from which the global effects of humankind's transformation of the Earth begin to become noticeable (2000). Terraforming narratives engage with the Anthropocene in the sense that they explore precisely such transformations at the geologic and ecologic level.

Cities in terraforming narratives are interfaces through which humanity transforms its relationship to nature by adapting the external world for their own ends. An overriding motive for this transformation is a feeling of Promethean fear, a fundamental sense of humankind's asymmetric relationship to a nature that constrains possibilities for human survival and flourishing. As Yi-Fu Tuan explains, it is this sense of asymmetry that informs the urge to escape from nature into culture: "[t]he familiar story of people altering nature can thus be understood as their effort to distance themselves from it by establishing a mediating, more constant world of their own making" (10). James Rodger Fleming has examined how contemporary interest in geoengineering recapitulates the history of cloud seeding to control rainfall in the Western states of America throughout the nineteenth and twentieth centuries, especially when cloud seeding was seen as a technological solution to the effects of drought in the nineteenth century and the dust bowl in the early twentieth. Fleming describes this history as "[a] tragicomedy of overreaching, hubris and self-delusion" (2), explaining that "[t]he trinity of understanding, prediction, and control undergirds the dominant fantasies of both science and science fiction" (9). Technology promises to overcome the asymmetry between humankind and nature by placing humankind in control of forces that were formerly beyond their capacity to harness. As a literature of landscaping, terraforming narratives scrutinise the structure and implications of this dynamic of escapism for thinking about cities in our contemporary economic world system, itself a technological matrix designed, as Tuan argues, to facilitate an escape from the dangers and uncertainties of existence.

This paper argues that images of animals, plants and bacteria are fundamental to the way terraforming narratives conceive of cities as centres for the technological transformation of worlds and as spaces where reflection on the human relationship to non-human nature can be reconceived. This exploration is dialogic as later writers respond to their predecessors' depictions of cities and terraforming so as to refigure the relationship between human and non-human nature. They do this by examining the ways planetary adaptation encourages reflection on appropriate modes of habitation and the changes to the urban experience that such modifications entail. To highlight how a focus on animals and plants transforms the way the city is conceived in terraforming narratives, this paper begins by analysing H.G. Wells's *The Shape of Things to Come* (2013 [1933], hereafter *Shape*) before moving on to explore how non-human nature is incorporated into images of the city in the American pulp sf of the 1950s, the ecological sf of the 1970s-1980s and in Kim Stanley Robinson's *Red Mars*, *Green Mars* and *Blue Mars* (1993 [1992], 1993 [1994] and 1996).

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Scholars of urbanism have turned to sf as a tool for teaching and for engaging the imagination when it comes to exploring the social, political and economic ramifications of urban change. Carl Abbott identifies a heuristic function of sf that invites reflection about the nature of urban change ("Cyberpunk Cities" 129). Natalie Collie points out that sf's speculative aspect makes it more fully able to realise abstract, metaphorical or subjective orientations toward the future that are embedded in "our culture's ideas, dreams, fetishes and fears" (424–25). Myers and Kitsuse suggest that another consequence of using sf to think about issues in urban planning is that it may help to "demystify the future by reducing complexity while bringing multiple perspectives into consideration" (227), and thus it can help address profound uncertainties brought about by rapid technological change—what Alvin Toffler describes as 'future shock' (1971). Myers and Kitsuse see sf's capacity for storytelling as an important mode of communication that offers an alternative to the polarising tendency of debates grounded in analytical argument (229). Lynda H. Schneekloth describes urban planning, design and architecture as "*unredeemably utopian*" because it is driven by a utopian vision of an "'ought-to-be'" (23)—the same utopian impulse that narratives of terraforming interrogate. Much of the interest in sf amongst scholars of urbanism centres on the 1980s sub-genre of cyberpunk, namely for its portrayal of a future dominated by global cities, communication technologies and the corporate influence on society, politics and economics. As this paper will show, sf about terraforming is centrally concerned with many of the same themes and, especially after the 1960s, has incorporated an ecological perspective into its structure—one that was already implicit in earlier narratives.

As a literature that explores the Anthropocene, terraforming narratives are fundamentally concerned with change. The environmental philosophical concept of landscaping captures the sense of space as a hybrid of both culture and nature, and thus it draws attention to the ways humankind projects meaning onto the external world and transforms it for their own anthropocentric purposes. Simon Hailwood defines "landscape" as "nature insofar as it is modified and interpreted for *human oriented ends*, moulded and used, or viewed as malleable and useful, for human interests and needs" ("Landscape, Nature, and Neopragmatism" 132–33; emphasis in the original). Hailwood extends Holmes Rolston III's definition of landscaping to include intellectual processes, explaining that "landscaping [is] the ongoing historical process through which humanity physically shapes its environment[,] fills it with symbolic meaning, historical and aesthetic significance, and so makes itself at home" (Hailwood, "Landscape, Nature, and Neopragmatism" 133). Landscaping, when extended to encapsulate the intellectual, usefully coheres with a range of models for analysing space, from the Bakhtinian chronotope (2002) to Edward W. Soja's notion of the urban imaginary (2000). Ideas of a utopian space that "ought-to-be" and which underlies urbanism are themselves intellectual landscapes. Fundamental to Hailwood's notion of landscaping is the concept of nature's otherness, which refers to the relatedness of aspects of non-human nature to humankind. Hailwood argues that nature's otherness is present "'from the streetcorner to the stratosphere'" and that it is an inescapable element of all human environments (*How to Be a Green Liberal* 35). In that sense, nature is an ever present element of our

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cities. Narratives of terraforming use this crucial notion of a blending of nature and culture to explore the ways in which nature is expelled, obscured or integrated into cities to examine the repercussions of these responses to nature's otherness.

While the technological adaptation of Earth has been referred to as geoengineering since the 1990s, sf has often collapsed the distinction between adapting extra-terrestrial planets and adapting or terraforming Earth. Scientific romances of the fin-de-siècle often depicted the destruction of cities through future wars, which highlighted civilisation's fragility with respect to the growing technological capability of nations to exert control over their neighbours. The future war subgenre of the scientific romance reflected anxieties surrounding the social and demographic changes that technology and urbanism were bringing to cities and agricultural space in Europe. Both H.G. Wells and Olaf Stapledon wrote sweeping future histories involving episodes of terraforming or geoengineering that incorporated the future war sub-genre into their structure. The vast temporal perspectives of these works allow Wells and Stapledon to present and reflect upon cities in the changing contexts that arise over long periods of time. They show the growth and decline of civilisations to be a consequence of natural crises, access to resources or political and socio-cultural harmony and conflict. Wells and Stapledon influenced the development of pulp sf in America and provided images of cities that would inform the public imagination of urbanism and architecture. Examining Wells's *Shape* to explore the ways in which the relationship between cities and non-human nature—in the form of metaphorical and literal depictions of animals and plants—are portrayed will illuminate the tradition of scientific progress, global unification and control over the external world that later sf would inherit and write against.

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H.G. Wells's *The Shape of Things to Come*

Wells's *Shape* invites reflection on the relationship between civilisation and a non-human nature (bacteria, plants, animals and natural forces) that spurs the growth of urbanism. While terraforming does not occur in this work, geoengineering does: geogonic planning is the narrative's term. Inspired by Stapledon's *Last and First Men* (1966 [1930]), Wells depicts the growth and decline of Earth's civilisations according to a dynamic involving increasing sophistication and technological control over the environment, which eventually culminates in geoengineering. Throughout *Shape* the narrator reflects on the dirt and grime of industrial London, on its slums and on plagues that take their toll on the population. London is depicted as a war city early in the narrative, thus recalling the First World War and anticipating the blitzes of the Second World War, but toward the end of the work we see a London divorced from the underground tunnels and chambers used to shield Londoners from bombings or the dilapidated cities and ruins that are left after the numerous conflicts recounted in the narrative. This London of the past is compared to a future London of ease, with its expansive and hygienic streets and its scientifically managed pastoral spaces. *Shape*

portrays a city undergoing transformation, an example of how cities 'live and breathe,' as the common metaphor for the city as organism intimates.

In much sf including Wells's future histories and Stapledon's "essay[s] in myth creation" (*Last and First Men* 12),[2] cities such as London appear as political and economic agents, global cities that act in an international arena. Major cities are incorporated into a catalogue of urban environments that are grouped together because of their political, economic and historical significance. This abstraction is important for how terraforming narratives would later establish a contrast between terrestrial and alien cities. The cities that are of particular interest to the narrator are those that grow to become global megacities in a world system of economic exchange and expansion.

One effect of Wells's survey is that a series of contrasts are established that show how contingency and desire interact to shape the city. The desire for stability and an improvement in living conditions ultimately leads humankind to modify their environment and so overcome the disasters that have devastated the population in the past. This approach to progress is subject to events at the international and ecological level, such as war, pestilence, environmental destruction and the contrary desires of others. That it is with populations rather than individuals that these future histories are primarily concerned underscores how centrally involved these narratives are with issues of urbanism and town planning. Hope Tisdale defines urbanism as "a process of population concentration" (311) and argues that "technology is the sine qua non of urbanization" (315). The industrial revolution is Wells's starting point for reflection on the process of urbanisation, thus positioning *Shape* as a meditation on the Anthropocene. *Shape*'s treatment of the city reflects concerns about the migration of peoples from agricultural to urban environments throughout Europe and centrally in England. Wells's narrative portrays the result of these technologically driven migrations as the formation of a world system of megacities. The narrator approvingly describes "this world system as a vast business octopus, with the Air and Sea Control as its head and the other Controls as its tentacles" (Wells, *Shape*). This network ultimately offers a system of control that addresses Promethean fears toward an unpredictable nature. It explores the relationship between technology, population concentration and the image of the capital megacity, using the form of the future history to dramatise their development over time; later terraforming narratives establish such contrasts spatially.

Imaging this world system as an octopus is an instance of landscaping that goes some way to naturalising the global network by aligning it with non-human nature. The image of the octopus is itself landscaped with human-centred meaning that emphasises its radial structure, multiplicity of action and centralised control. This network is a blueprint to which the rest of the global population is incorporated and brought into alignment with the ideological underpinnings of the Air and Sea Control. Although animals are often backgrounded in terraforming narratives and in much sf, their relationship to the city is raised in *Shape* and can clarify how the text imagines nature's integration into the world system of cities. Just as the rest of the global population is

[2] Brian Stableford explains that these essays in myth creation "construct imaginary worlds to embody metaphysical theses" (138).

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brought under the sway of the Air and Sea Control, animals and plants are integrated into a world system of cultivation and husbandry, which is eventually supported by extensive biological research. During a period of global warfare during the Age of Frustration earlier in the text, the narrator records how pets and synanthropes—wild animals that have adapted to benefit from their proximity to human inhabited environments such as cities, gardens, and parks—are exposed to a "Permanent Death Gas" that renders large regions uninhabitable. Not only humans, dogs and livestock, but "millions of mice, rats, birds and suchlike small creatures" are exterminated as a result of the application of this weapon of mass destruction. That these biological weapons of war indiscriminately affect synanthropes and other wild populations of animals and not just pets and livestock—which are already incorporated into the spaces of the city and the country—underscores the far-reaching and unanticipated influence of technology on biology. A secondary effect of this Permanent Death Gas is a "Sterilising Inhalation" that renders all non-avian animals, including humans, infertile (Wells, *Shape*).

This episode anticipates the connection that Rachel Carson makes in *Silent Spring* between chemical pesticides and military research into biochemical weapons. Carson writes that the chemical pesticide industry of the 1950s is "a child of the Second World War" and that "insects were widely used to test chemicals as agents of death for man" (16). Later in *Shape*, one researcher discovers that gases derived from the Permanent Death Gas can be used to affect, "abundantly and controllably," mutagenic changes in the chromosomal structure of animals, thus making possible the "[t]he artificial evolution of new creatures." This leads to an important intervention into genetics that shows how animals and the natural world is to be integrated into the world system of cities. Fifteen "Major Parks" are created to ensure the undisturbed flourishing of flora and fauna (except by "qualified observers"). Their purpose is to provide a reservoir of genetic material for research into the genetic modification of captive animals and the restoration of extinct species. As the narrator reports, "[m]ost of the 'wild beasts' of our ancestors are now under control in their special enclosures and reservations" (Wells, *Shape*). This pastoral image of a highly ordered and clearly demarcated world made possible by technological innovation and an expanding urbanism highlights the centrality of the image of the city as an engine of destruction, transformation and creation, an interface that expresses society's values with regard to the function of cities and the ways in which non-human nature is integrated into its structure.

Nature in *Shape* is malleable and subordinate to the will of the elite responsible for managing the world system. Their managerial efforts flatten the heterogeneity of cities, making them homogenous and bringing them into alignment with a blueprint devised by a scientifically-minded elite. Other works of this period explore the same themes in the context of terraforming, notably the British pulp sf writer John Russell Fearn in "Earth's Mausoleum" and, as has already been mentioned, Olaf Stapledon. Space does not permit a detailed discussion of the latter's *Last and First Men* and *Star Maker* (2004 [1937]), but it is worth pausing to consider how Stapledon's works contrast with Wells's vision of a march of progress and conquest of nature.

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Stapledon's essays in myth creation take the logic of evolution to its extreme. In *Star Maker*, the narrator observes a vast array of alien civilisations evolved from a variety of species with urbanising tendencies appropriate to each. The reader is given a sense of the contingency and the sheer scope of possibility associated with urbanism. A similar dynamic between fending off nature and conquering nature appears in these works, yet Stapledon refuses to portray humankind's inevitable triumph. In contrast to Wells's optimism with regard to a given society's capacity to wield technology to recover from a catastrophe and to facilitate urban expansion, the reader is instead encouraged to reflect on the limitations and contingency of human life and urban existence. Catastrophe, for Wells, is thus an opportunity for urban and social renewal. In *Last and First Men*, the eighth iteration of humanity begins the terraformation of Venus so as to escape Earth's destruction by asteroid strike. The processes of urbanisation brought to Venus first overlays, then erases pre-existing ecologies and the undersea Venusian civilisation. There is no attempt to integrate these two systems.

These scientific romances background non-human nature and their relationship to the city insofar as the autonomy of non-human life is overlooked when integrating nature into plans for urban expansion. The city is the node from which technological change expands outward to transform nature and mitigate Promethean fears toward its asymmetric and seemingly implacable relationship to humankind. A struggle over taming nature and harmonising urban life is central to these stories. In Stapledon's case the dramatisation of multiple alien civilisations works to emphasise the vast array of permutations available to expanding societies. Pastoral structures and images are used to frame this conflict between expanding urban centres (and a corresponding expansion of power and control over nature) and an expansion that seeks to integrate nature into urban space. In *Shape*, this is in the form of designated spaces, parks that reinforce urban power. In Stapledon's work, the various iterations of humankind adapt themselves to their new environments and experiment with different modes of integrating nature into urban space. The Seventh Men in *Last and First Men*, for instance, fascinated with the utopian symbolism of flight, modify themselves and their cities for a pastoral existence as winged creatures. This utopian vision of a communal avian city dominated by megastructures upon which these humans alight illustrates how these works depict urban space as representative of a civilisation's system of value. Ultimately, they portray the process of urbanisation as an inevitable expansion from small townships and cities to vast megacities. This growth, however, is dependent on the wise use of technology to incorporate and control non-human nature in order to guard against natural catastrophes or a human-driven destruction of the environment that would precipitate urban collapse.

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Arthur C. Clarke's *The Sands of Mars*

The first novels devoted to terraforming appeared in the 1950s. Robert Heinlein's *Farmer in the Sky* (1967 [1950]), Arthur C. Clarke's *The Sands of Mars* (1976 [1951]) and Ray Bradbury's collection of short stories, *The Martian Chronicles* (1958 [1951]), explore

the ways in which the colonisation of other planets focusses attention on the potential integration of cities and an alien, non-human nature. Abbott calls these homesteading stories, "for they draw on the rich experience and mythology of the American farm-making frontier." These narratives represent interplanetary colonisation in terms of the American pastoral, a central mode in sf for engaging with issues surrounding technological change. "[T]reatments of homesteading in sf, with their emphasis on rugged individualism," Abbott argues, "seem to stand in clear contrast to large-scale terraforming novels that retell the 'modern' story of big science and state action" ("Homesteading on the Extraterrestrial Frontier" 242). These narratives emphasise individualism and small, tight-knit communities in contrast to Wells's vision of an urban centre of control managed by a scientific elite. This libertarian strand would gain increasing currency throughout the 1960s-1970s and is explored in such works as Heinlein's *The Moon is a Harsh Mistress* (2001 [1966]), Ursula K. Le Guin's *The Dispossessed* (2000 [1974]) and Michael Allaby and James Lovelock's *The Greening of Mars* (1984).

Relationships with animals are certainly backgrounded in these narratives and can be accounted for by the knowledge of the scarcity of life on other planets at the time, but in these stories we see how the absence of animal life sharpens our awareness of a lack in our contemporary urban experience. While animals in the form of pets or livestock are excluded from the colonising outposts of the first interplanetary cities, synanthropes are not completely absent and are valued because they are fundamental to the success of the terraforming project. Furthermore, in *Farmer in the Sky*, *The Sands of Mars* and *The Martian Chronicles*, the appearance of alien life or evidence of such life speaks of a desire to connect with the other. How far this theme allows us to explore the potential integration of nature into interplanetary urban systems is dependent on how these aliens are presented in the narrative—whether as members of an alien civilisation and thus comparable to human societies or as non-sentient animals comparable to terrestrial non-human fauna. The discovery of evidence of an alien culture at the end of *Farmer in the Sky* and the haunting of the Martian colonists by Mars's former inhabitants in *The Martian Chronicles* clearly align aliens with civilisation. In *The Sands of Mars* the aliens that are discovered are apparently non-sentient, non-human animals.

Contrasting the interplanetary colonial city to terrestrial global cities such as London, New York and Paris often raises a criticism of the colony's frontier status which, the colonists hope, will only be transitory. In *The Sands of Mars*, Gibson's first view of the capital, Port Lowell,[3] is of a small frontier town, most of which is underground. Port Lowell's various functions—food-production, biological and engineering research and energy—are distributed in domes that are separated from the residential sectors of the city. "I'm used to the standards of London and New York," Gibson tells the mayor: "[a]fter all, two thousand people would only make a large village back on Earth" (Clarke

[3] Port Lowell alludes to Percival Lowell, the author and astronomer who popularised Schiaparelli's identification of canali on the surface of Mars as signs of a vast irrigation project designed to stave off civilisation's collapse by managing water scarcity on the planet (Lowell 128). Terraforming has thus been embedded in scientific speculation about Mars since 1895.

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162–3). The opening of a new dome the following week, the mayor tells Gibson, promises to give the colonists the space to expand and eventually rival Earth's cities. These domes are transitory stages in the eventual terraforming of Mars which promise the colonists the freedom to build cities according to the model of Earth. Another character later tells Irene, the mayor's daughter, that "[i]t's not right that you should stick here on Mars and never see anything of Earth. Paris—New York—London—why, you haven't lived until you've visited them" (Clarke 312–3). The small, bare cities on planets undergoing terraformation cannot compete with the wealth of history and sheer physical presence of the cities of Earth.

After the novel establishes the colony as a regenerative space where time unfolds as a process of personal healing and socio-political reconstruction and self-determination, the narrative turns its attention to resolving anxieties over colonial relationships with indigenous cultures by invoking the theme of the discovery of alien civilisations. The colony's only interaction with the aliens is through a young representative who, unlike the adults of its group, appears unusually curious and follows Gibson back to the colony. Gibson feels no qualms over making use of the aliens to cultivate Mars by training them to plant genetically engineered 'airweeds' native to Mars across the planet in order to make the atmosphere breathable. Port Lowell is dependent upon the integration of flora and fauna in order to make survival viable and to facilitate the growth of further cities across Mars. The aliens represent the promise that humankind is not alone—that other intelligences capable of communication exist throughout the universe:

> However he might shape it for his own purposes, it would be his duty always to safeguard the interests of its rightful owners. No one could tell what part they might have to play in the history of the universe. And when, as was one day inevitable, Man himself came to the notice of yet higher races, he might well be judged by his behaviour here on Mars. (Clarke 200)

The ideal of contact with "higher" alien civilisations and the external evaluative role that they might play function as a check to the colony's ethical standards. Hadfield reminds the colonists that they are "making history," creating the foundations for a future of terraformation to which other generations of humankind will be indebted (Clarke 188). The first experiments with terraforming therefore involve attempts to formulate sound ethical relationships within and between species. These ethical considerations underpin a colonial project extending beyond the solar system that struggles to escape a repetition of the record of oppressions observable in Earth's own history.

Terraforming stories emphasise the fundamental dependence on non-human nature for transforming alien planets into habitable environments. In many homesteading stories, soil construction is a key terraforming technology that depends for its success on the action of fungi, bacteria and worms, thus making these synanthropes essential to the survival and flourishing of interplanetary colonies. By portraying the difficulties involved in creating, maintaining and expanding cities on other planets, these narratives underline the impossibility of escaping from a dependency on non-human nature, thus preserving a sense of humankind's asymmetric relationship to that nature. Speaking of Heinlein's *Farmer in the Sky* as a homesteading story, Abbott explains that,

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> Like much Golden Age sf, the fun comes from imagining technical details, as the problems of earthside soil conservation, a major issue of the middle decades of the twentieth century, are inverted into moonside soil creation. (Abbott, "Homesteading on the Extraterrestrial Frontier" 247)

These narratives respond to the environmental and agricultural degradation of the 1930s American and Canadian experience of the dust bowl. Terraforming narratives transpose and refigure environmental concerns onto the spaces of other planets, re-situating them in the context of an accelerating urbanism that threatens to erase an alien, non-human nature. In *Farmer in the Sky* and Kim Stanley Robinson's 1990s *Mars* trilogy, the difficulty of constructing soil on Mars is partially overcome by importing it from Earth. The cities of other planets are thus dependent on Earth's support even as they attempt to achieve independence and self-sufficiency. Interplanetary colonies are doubly fragile, reliant as they are on their ability to adapt to an alien environment and the possibility of weaning themselves from Earth's influence.

Frederick Turner's *Genesis: An Epic Poem*

In his 1988 *Genesis*, Frederick Turner explains the provenance of his epic poem with reference to Arizona's Biosphere-II, still under construction at the time of publication. It was eventually opened in 1991 and hosted the first of its occupants to widespread public attention and controversy. Biosphere-II is an experiment in sustainable, closed environments that attempts to duplicate Earth's ecosystemic processes to better understand the operations of its biosphere and, secondarily, to function as a prototype for space colonies. The eight subjects of the first experiment maintained self-sufficiency for the length of the two year trial, which involved the production of their total food supply and the management of oxygen, water and nutrient cycles. In "A Note on the Science of *Genesis*," Turner explains that architects such as Paolo Soleri, who designed contained arcologies, have long imagined structures such as the biosphere, and he connects Biosphere-II to the insights posited by Lovelock's Gaia hypothesis (*Genesis*). Buckminster Fuller's geodesic and the long tradition of imagining domes in sf fed into the conceptualisation of Biosphere-II. The experiment was informed by the search for solutions to environmental problems through innovative ecological thinking and design, the appropriate use of technologies and environmental advocacy. This approach was pragmatic and optimistic in orientation and promoted conscientious use of environmental research and science to explore alternatives to contemporary practices and to affect wide-ranging change through the mobilisation of individuals who would take the shaping of their destiny into their own hands.

Stuart Brand's *Whole Earth Catalog* was the voice of this tradition and its popularity inspired many to explore ways to engage with environmental issues. *The Whole Earth Catalog* collects a range of articles from reviews of books and technologies, surveys of the work of various thinkers on a range of disciplines, historical primers and other items, all of which are subordinated to the subtitle of the text, "access to tools." Among articles on Buckminster Fuller and tensile structures, the first issue reviewed

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Steve Baer's *Dome Cookbook* (1967) and the geoengineering text *Man's Role in Changing the Face of the Earth* (1956), along with Frank Herbert's terraforming novel, *Dune* (1963). In the 1970s-1980s writers such as William S. Burroughs, Ursula K. Le Guin, Ernest Callenbach and William Gibson contributed to the *Whole Earth Catalog*, its successors and revivals, along with the scientists James Lovelock and Lynn Margulis. Brand controversially explored the issue of space colonisation and produced a collection on the theme entitled *Space Colonies* (1977), which was influenced by the ideas of Gerard O'Neill and which emphasised the link between sf and the pragmatic, technologically oriented environmentalism of the *Whole Earth Catalog*. Although Andrew G. Kirk notes that the *Whole Earth Catalog* is informed by an environmental utopianism that was especially clear in the debate over space colonies, he argues that "[t]rends that were initially utopian often get tempered by time, evolving into more practical versions of the revolutionary thinking that spawned a period of great creativity" (10). Sf influenced the revolutionary thinking Kirk describes; the dialogism of the mode can be seen as a feedback system that refigures tropes and narratives in response to the needs and desires of society. Like the *Whole Earth Catalog*, the terraforming tradition can be read as a catalogue of tools for adaptation and as responses to landscaping and technologically driven societal change.

Frederick Turner's *Genesis* inherits this ecological tradition and reflects on the possibility of creating a new city on Mars that would incorporate nature and culture in ways that would respect the heterogeneity of both domains. *Genesis* recounts the struggle between Earth's Gaean Theocracy and Martian colonists led by Chase 'Chance' Van Riebeck. Earth in this narrative has locked itself into a technological infrastructure that rejects innovation in the name of conservation, thus preventing genuinely sustainable urban systems and technologies from emerging. Mars colonisation represents an escape from the confining strictures of Earth's flawed environmental paradigm and an escape to a utopian future that synthesises technology and nature. Essential to the Mars project is the complete genetic record of extant animals on Earth, the Lima Codex, which would allow the colonists to populate their terraformed world with non-human animals. The Gaean Theocracy forbids any intervention into nature, human or otherwise, which makes Chase's bid for terraforming and genetic engineering anathema. During Chase's trial the prosecution questions Beatrice on the prehistoric animals that she has cloned and offers evidence of further crimes conducted on Mars:

> These samples here of deformed animals
> And prodigies with leaves and mouths and lungs;
> These photographs of what was done on Mars,
> Showing the ancient landscape now convulsed
> And slobbered over with a noxious slime. (Turner, *Genesis*)

The "prodigies with leaves and mouths and lungs" certainly resonate with dystopic images of animals tortured into new forms, images that can be traced back to Mary Shelley's *Frankenstein* (2008 [1818]) and H.G. Wells's *The Island of Dr. Moreau* (2008 [1896]). The first stages of terraforming transform the world into a landscape that reflects the worst visions of the future. Significantly, the prosecution carefully avoids

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any reference of Earth's evolutionary history for fear that such an admission would naturalise the introduction of life to Mars and thus justify the colonists' endeavour. Since terraforming other planets could then be framed as recapitulating Earth's own evolutionary history, terraforming could conceivably be integrated with Gaean doctrine. Wells's utopian vision of a world system of cities and "new aberrant animal types in our experimental gardens" (*Shape*) is refigured in *Genesis* as an oppositional vision of the future relationships to nature that humankind might create in their struggle to realise their utopian visions.

The colonists' first cities are claustrophobic and stifling, recapitulating images of the dystopian city; the narrator notes how "[t]his little cave-hole on the tortured planet / Can be a place of terror" (Turner, *Genesis*) and records how

> Beatrice yearns after animals
> Upon this world of silent growing plants;
> Perhaps they miss the fleshmeat in their meals –
> Such petty changes can engender turns
> Of the spirit as lonely, dark, and cruel
> As any struggle over principle,
> Standing in tears amid the alien corn. (Turner, *Genesis*)

Although the colonists have successfully managed to establish an agricultural infrastructure, their crops are as alien as the world they now occupy. A sense of place, of Mars as a home, eludes them, and they turn to the establishment of animals on the planet as an answer to the loneliness of existence on Mars. This loneliness chimes with Clarke's notion in *The Sands of Mars* that "life called to life" and that "[e]verything that grew or moved upon the face of any planet was a portent, a promise that Man was not alone in this Universe of blazing suns and swirling nebulae" (67). The escape from nature that the city and terraforming offer only highlights an emotional and cognitive dependency on non-human animal others for creating a sense of belonging. The absence of a wider ecology that would add complexity to the urban infrastructures established on Mars and which would supply the colonists with animal others that would encourage them to cultivate a sense of the city as a home makes their terraforming project a hollow achievement. The narrator's half-hearted explanation for this yearning as attributable to a lack of meat is unsatisfying because it cannot account for the scope of the colonists' alienation from an alien nature.

In response to this ecological deprivation the colonists in Act V Scene ii, "Evolution and the City," begin to re-imagine the possibilities for urban experiences on Mars: "Charlie and Ganesh have broached the Ark / And let forth all the curious animals" (Turner, *Genesis*). Allusions to Biblical, Greek, and epic traditions from around the world frame Mars as a space for the convergence of multiple human histories and traditions. What follows is an epic catalogue of animals that emphasise their aesthetic, physical and anthropomorphised qualities and values:

> But Charlie and Ganesh had more in mind
> Than filling out the plenum of a zoo;
> They were composing a community,
> A new branch of natural history. (Turner, *Genesis*)

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Animals are incorporated into the Martian community as essential companions with interests and behaviours that are not dependent on humankind or their cities, though they are dependent on terraforming technologies. They are not simply animals to be observed by curious and alienated humans *pace* Wells, but are members of a community that includes humans. The implications of this re-writing of the relationship between humans and animals for the nature of the city is dramatic and it encourages the colonists to view the creation of a new civilisation in terms of establishing cities as participants in ecological networks. Although animals on Earth are not dependent upon humans for their existence and flourishing, on Mars their existence is ultimately dependent upon humankind's creation of a viable biosphere, which in turn is dependent upon the robustness of the ecologies they are able to establish. This structure is a closed feedback system that emphasises the initial dependence of life on the creation of this "new branch of natural history." Reflecting on how the swan "owes its being to a hierarchy / Of other organisms," the narrator insists that "We must learn / To find the beauty in this web of lives, / This seething texture of dependency" (Turner, *Genesis*). Evolution and ecology are aligned with an aesthetic sensibility that is central to the creation of a utopian civilisation on Mars.

The importance of animals for the city is encapsulated in the utopian image of an "avian city, avian economics, and avian ethics," which echoes Stapledon's treatment of the Seventh Men and their avian cities in *Last and First Men*. This metaphorical application of the avian to the citizens of Mars functions as an intellectual landscape that familiarises the Martian city by aligning it with a history of utopian imagery. The image of flight appears in Turner's earlier novel of terraforming, *A Double Shadow*, in Stapledon's *Last and First Men* and in Kim Stanley Robinson's *Mars* trilogy. Turner notes that "For Aristophanes the avian city / Was orgiastic as the land of dreams." Later, the narrator attributes to Socrates the notion that "we must construct an airy city / If we would so articulate the good / As to make justice worth the defining." Not only must the beauty of evolution and ecology be recognised but the Martian colonists "must learn to fly" (Turner, *Genesis*). It is the new generations who first take to the skies to claim their inheritance:

> nature
> Makes us dream of being mighty birds,
> Coasting the buttresses of mountain chains,
> Lifting away upon a breeze of power,
> Escaping monsters, terrors, to the air. (Turner, *Genesis*)

The motif of flight represents both an escape from the monsters and terrors of the imagination and civilisation and a recognition that it is the beauty of nature's otherness that encourages this flight. It is both an escape from earthbound nature—which is representative of destructive stasis—and an escape to a better life. But it is also a way to step back and view the city and the Martian landscape from a radically non-human perspective: that of a utopian, avian citizen who is part of a larger community that includes non-human others. Mars's gravity—which is one-third of Earth's—means that this element of nature can be framed as a powerful figure for the possibilities offered to

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the Martian colonists for creating a better civilisation on Mars: "Here some of you can leap to twice your height" (Turner, *Genesis*).

Flight offers an escape from nightmare and a connection to nature. The Martian Sibyl relates wings to our phenomenological experience of time and asserts that "underneath the surface structure / We knew the time of animals and plants, / The time of stones and atoms, and of fire." This sense of non-human nature as offering a fundamental connection that would help the colonists to construct a viable alternative to Earth's destructive stasis is ratified by the Martian constitution and plans for a city grounded in this image of flight: "Imagine then a city made for birds. / First, this cloudcuckooland is made not found" (Turner, *Genesis*). This utopian city is not a given and does not automatically follow from the establishment of colonies and cities on Mars. Rather, it is a place that must be built. By connecting the foundations of this city to the motif of the bird, radical changes of orientation to the future of law and ethics are made.

Consider, for example, the notion of property, the figure for which is the wall. Because, as the narrator tells us, flight means that "No property on Mars can be fenced off, / And no one be fenced out," the notion of private and public space must undergo a radical revision. Instead of property rights established by the law, "property, possession, change their meaning. / They are the sign of neighborhood and trust, / The gratitude of the community" (Turner, *Genesis*). The economy, too, undergoes a revision as the significance of property for this Martian city is re-valued:

> Consider then a new oeconomy
> Of spirit and the making of the spirit.
> It is a floating world, where wealth is what
> Accrues about the things we give away. (Turner, *Genesis*)

Property accrues value according to how far it enhances education, storytelling, scholarship, athleticism, philosophy or the bonds of human affection. The notion of value as embodied by material objects thus undergoes a revision in this proposed gift economy. The Martian city, then, is an interface between humankind and their wider environment. The values embedded in the expanding city are an expression of new relationships to each other and to nature. Flight across the Martian landscape—most notably around Olympus Mons, the largest volcanic structure in the solar system—has the capacity to orient new generations toward the epic task of constructing a new society on Mars. Indeed, flight itself embodies an important lesson that discloses the final escape from nature that immortality promises: "Death in the air is but a part of life, / For who'd forgo the ecstasy of flying?" (Turner, *Genesis*).

Kim Stanley Robinson's *Mars* Trilogy

In Kim Stanley Robinson's acclaimed *Mars* trilogy, Martian colonists establish cities that become objects of struggle between Earth's various multinationals and those colonists who reject the notion that Mars is simply a resource for Earth's industry. The domed cities in this trilogy underscore civilisation's fragility as, during the first war for independence in *Red Mars*, the strategic destruction of oppositional domes successfully

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counters the revolution at great cost to the lives of the colonists. The fragility of the domes and their status as containers that set physical, political and socio-cultural limitations on the colonists illustrate the correspondence between physical and metaphorical space while figuring an anxiety at the heart of civilisation's technological capacity to shape new worlds through an application of politically directed science.

There are other perspectives on Mars and throughout the trilogy they are discussed, argued against, modelled, experimented with and subverted in various ways and from a variety of subject positions. As the narrative progresses the Martian cities are increasingly associated with different stances regarding the appropriate approach for colonising Mars. For example, the second Martian city, Burroughs,[4] is located near a space elevator that connects Earth and Mars. It is the centre from which Earth's multinationals expand their operations to exploit Mars' natural resources. Concentrated in this city are the business elite and Earth's security forces, who are used to exert control over the other cities of Mars. In contrast, Tharsis Tholus stands in opposition to the values associated with Burroughs. This city is populated by Bogdanovists[5] who oppose the strip mining of Mars and who provide support to the Martian Underground, a loose affiliation of groups who attempt to create new forms of habitation that reject the multinationals' instrumental view of Mars. Each section of the trilogy is narrated from the perspective of a different character while each instalment extends the political and ethical debates regarding the colonisation of Mars and its secession from Earth as an independent, revolutionary nation. Environmental philosophy is incorporated into the debates of the text as is reflection on extreme environmental positions such as deep ecology and the economic philosophy of business-as-usual. Ultimately, this work is ecotopian in its exploration of society and the environment and is encyclopaedic in the utopian sense of surveying multiple levels of the construction of a new society. The colonists' discovery of a life extending treatment allows Robinson to work with a larger temporal canvas for this exploration of urbanism, nature, science and society.

Central to the *Mars* trilogy's exploration of humankind's relationship to non-human nature is the Red / Green debate, a philosophical dispute over the merits of terraforming Mars. Strong Greens believe that providing life to the planet is a duty, and that any means should be considered in drawing up plans for terraforming Mars. Strong Reds, on the other hand, believe in complete non-interference with Mars' non-human, abiotic nature, and some use violence as a means of protecting the planet. These positions exist at the poles of a spectrum that all the colonists populate. The first colonists to Mars are a group of one hundred scientists, two of whom become the symbols for these movements: Sax is a physicist turned biotechnologist, a supporter of a heavy industrial model for terraforming Mars who modifies his position after he is captured and tortured by Earth's security forces for his role as one of the legendary

[4] Burroughs alludes to Edgar Rice Burroughs and his seminal John Carter of Mars series, which began with the serialisation in *All-Story* of "Under the Moons of Mars" in 1912, later novelised as *A Princess of Mars* in 1917.

[5] Taking their name from Arkady Bogdanov, an influential member of the First Hundred, this movement is also an allusion to Alexander Bogdanov, an sf writer who wrote the Martian Bolshevik utopia, *Red Star*, first published in Russian in 1908 and translated into English in 1982.

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generals of the first war of independence. Ann, his rival, is a geologist and a Red who adheres to her strong position until after Sax's change of view and her exposure to the violence of some of the radical Red movements (who see her as their legendary figure). Her turn towards compromise is precipitated by her encounter with the genetically modified life on Mars, a life that she had been ignoring in favour of the original Martian landscape. She realises that whatever nature existed on Mars is no longer there. The Red / Green debate drives the philosophic speculation of the text; this opposition allows Robinson to scrutinise the relationship between non-human nature and the human, represented by the polyphonic range of cities on Mars.

Genetic engineering features in the trilogy in several ways: through the life extending treatments already mentioned and through body modifications on Earth, but primarily through a series of modifications to organisms on Mars that both facilitates the ecopoietic transformation of the planet and equips lifeforms for habitation of a partially terraformed Mars. The first intervention involves distributing modified lichens that would bootstrap a process of modification to the atmosphere. This process is modelled against theories of the advent of life on Earth popularised by James Lovelock's Gaia hypothesis which replicates a model for the origin of Earthbound life on Mars. What this says about nature is intriguing: this is a technological intervention, a second nature that obliterates the 'authentic' nature of Mars in accordance with what Bill McKibben has described as the end of nature (1990). The idea that there is no nature is one of the perspectives voiced throughout the text and it runs directly into issues of politics: this first intervention was secretly conducted by Sax so as to bypass the Red / Green debate and questions over the most appropriate way to terraform the planet. Sax's intervention is also a harbinger of the failure of democratic processes for deciding if, and how best, to terraform Mars: as corporations and immigrants arrive, mining begins in earnest. The economic relationship between Mars and Earth threatens to bypass further debate over the appropriate mode of habitation of the planet. Nature, in the sense of an extraterrestrial wilderness untouched by humankind, is completely elided as these new forces extend the idea that Mars is simply a blank slate for the imposition of economic and political relationships developed on Earth.

In *Blue Mars*, increasing numbers of plant and animal species are modified as the now independent planet has been transformed into a functioning system economically and culturally tied to Earth. Polar animals, modified for the Martian environment, begin to establish the first diverse ecology on Mars. Ann's confrontation with a polar bear forces her to acknowledge the vitality and transience of nature. Even though she recognises the second nature of these organisms she begins to view the separation between nature and culture in less oppositional ways. Nature has never been an unproblematic concept; Ann's strong Red position is based on the ability to make a distinction between culture and nature but, once Mars has become inhabited, this distinction rapidly breaks down. As some of the colonists, including Sax, begin to engineer their own bodies with genes from various animals for both survival and for pleasure, the separation between a coherent human image and one that blends with non-human animals further compounds this issue.

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The terraforming narrative, with its attention to life-support systems and domes, brings into focus the precarious nature of the terrestrial city as life-support system. The recognition that interplanetary colonies can reject the models that Earth offers for shaping the tenor of urbanism on Mars invites speculation on new modes of habitation. Arkady Bogdanov explores this utopian impulse with great enthusiasm when he argues, "'I've already lived too long in a country that thought only of utility. We must show that we value more than that here, yes?'" His vision of possibility helps to inspire the multitude of alternative designs for cities that arise on Mars. Important to Arkady's vision is that these cities blend with the original Martian landscape. In response to one criticism that establishing a viable living space will necessarily damage the land, Bogdanov argues otherwise, claiming that "'[i]t is a matter of spirit! And that's not to say it could have been done earlier, the infrastructure had to be installed, that's always messy, but now we are ready for the art of architecture, the spirit of it'" (Robinson, *Red Mars* 161).

Conclusion

Bogdanov's appeal to an "art" or "spirit" of architecture echoes similar appeals that run throughout the terraforming narrative's exploration of the aesthetics of the city and its dual image as utopian and dystopian. Terraforming, as a process of landscaping, creates new worlds from the destruction and erasure of the old. Terraforming narratives structure their enquiry into the relationship between humanity and non-human nature around this act of world building, which resonates with the utopian impulse to remake sociopolitical worlds. Schneekloth writes that "[e]ach act of material restructuring of the world makes the world, adds to it. Designers are engaged in the ongoing activity of making the present. And the making of the present constructs the field from which tomorrow is made, and next year – the future" (12). The terraforming narratives surveyed in this article situate non-human nature in the form of animals, plants and bacteria at the heart of this enquiry into the shape of future cities.

This article has considered the role of the city in structuring the relationship between humankind and nature in the terraforming narrative. The theme of the conquest of nature that underlies many works of sf and which is exemplified by Wells's *Shape* is an expression of a desire to escape from a feeling of insignificance and vulnerability in the face of an overwhelmingly hostile nature. As humankind's technological mastery increases the capacity to shape non-human nature for human oriented ends, a void becomes apparent. The image of the interplanetary city as humankind's life-support system fails to provide a space for incorporating non-human others that would allow their inhabitants to embed themselves in a community that does not simply reflect human desires. The image of a utopian future becomes ever more firmly associated with ecology after the ecological turn of the 1960s-1980s. As Turner and Robinson show, the terraforming narrative's call to re-vision the city as an expression of a new system of value increasingly sees non-human nature as central to the utopian cities that the colonists struggle to create on other worlds.

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