

The Fabric of the City: Scarcity and Sustainability

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“Claustrospheres themselves consumed colossal resources in their actual production. The extraordinary irony was clear to all but the stupidest. The world was actually hastening its own destruction in order to survive it.”

Ben Elton, *This Other Eden* (1993)

Ben Elton's terrifying and darkly hilarious *This Other Eden* sees the corporate magnate, Plastic Tolstoy, successfully hasten the collapse of civilisation, in the name of individual liberty and the pursuit of capital.

I fear that as an architect practicing today, the shadow of the claustrosphere lurks within the buildings I have designed, that each new wall or lick of paint comes at a cost which I am ill equipped to calculate. In the UK where I practice and teach, the built environment accounts for 45% of carbon emissions, 10% of which is the production of raw materials. This paper is a part of my ongoing attempts to confront this truth. In response to this challenge I have, of course, turned to science fiction. Only within these imagined futures, the deep time of science fiction, can we begin to inhabit the repercussion of our climate futures.

In the first part of this talk I will discuss the notions of sustainability and scarcity in architecture, before looking at two science fiction novels Scott Russel Sander's *Terrarium* written in 1985, and Kim Stanley Robinson's *Red Mars* written in 1992, to look at how the built environment is shaped by radical shifts in the availability of energy and material resources.

I am using the term scarcity with a certain amount of trepidation. It denotes a way of conceptualising the implications of architectural design which challenges the dominant modes of thinking within the construction industry. The environmental impact of construction is typically framed in terms of sustainability, responding to the UN's sustainable development goals,¹ which ask us to “do more and better with less.” In the UK a building's sustainability is measured and assessed by the BREEAM system, where credits are awarded for things like the use of recycled materials and renewable energy. There are similar systems in the US where LEED w has a focus on water conservation, and Germany where DGNB prioritises economic sustainability.

This framing of sustainability is comforting to architects, effectively providing a compliance check list for moral absolution. It offers measurable technological fixes to complex problems, and delegates any challenging questions of responsibility to those who drafted the legislation. It also fails to critically question what we are sustaining, if, as suggested by the architect Jeremy Till, this includes existing consumer capitalism and its associated unjust power

¹ “The Sustainable Development Goals are a call for action by all countries ... to promote prosperity while protecting the planet. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth...” United Nations Sustainable Development Goals ‘17 Goals to Transform our World’

relations.² Sustaining capitalism necessitates continual growth, which, on a planet of finite resources makes the legislative ideal of 'sustainable development' an oxymoron. In response, architects have drawn on work in ecological studies to call for a shift in terminology, from sustainability to scarcity.³ For Till it's a term which reflects the notion of limits on resources, as well as their uneven social and global distribution "scarcity asks us to do things differently rather than to do the same thing with less."⁴ It allows architectural discourse to focus on the social and economic relations constructed by the architectural project, and question whether we should build at all.

To meaningfully engage with notions of resource scarcity, it is necessary to turn to the energy humanities, and the field of petro-cultures which considers the defining presence of oil within our contemporary moment. The relationships between systems of energy and architecture have been studied by scholars in the energy humanities including Timothy Mitchell in terms of the development of the industrial city, and Stephanie LeManager in terms of the automotive aesthetic which drives the planning of urban sprawl.⁵ But, as noted by Imre Szemen and María Whiteman, oil exists in a state of hidden ubiquity, a uniquely occluded substance which permeates our political and economic systems.⁶ To comprehend the hidden pervasiveness of oil, scholars such as Gerry Canavan, Caroline Edwards, Graeme Macdonald, and Patricia Yaeger, have suggested that the depictions of energy systems embedded within fiction, and particular science fiction might offer a way to consider how these systems have shaped ways of being in the world.⁷ The two novels considered in this talk, are both located in a time or a place beyond oil, depiction of futures where the scarcity of petro-chemical resources has necessitated the physical re-shaping of the city. These imagined futures offer us an opportunity to examine the limitations of contemporary conceptions of sustainability, opening up discussions regarding scarcity. While of course, they do not present complete or comprehensive depictions of a world, nor should they, there is just enough of what Kathleen Spencer calls the absent paradigm of the world within the text visible to be able to conduct a sustainable development BREEAM assessment.⁸

So, with clipboard and calculator at the ready, I turn to: Terarrium, set on a future Earth, where humanity is faced with increasing levels of environmental toxicity and responds with a process of structural enclosure in domed cities.

² Jeremy Till (2012) 'From Objects of Austerity to Processes of Scarcity' SCIBE (Scarcity & Creativity in the Built Environment) Working Paper 11

³ See: Architectural Design (2012) special issue on Scarcity: Architecture in an Age of Depleting Resources
Jeremy Till and Tatjana Schneider 'Invisible Agency', Jon Goodbun, Deljana Iossifova and Jeremy Till
'Themes of Scarcity', Michael Sorkin 'New York City (Steady) State' and Timothy Morton 'Everything We Need: Scarcity, Scale, Hyperobjects'

⁴ Jeremy Till (2012) 'Scarcity contra Austerity' Places Journal

⁵ Timothy Mitchell (2011) Carbon democracy: Political Power in the Age of Oil, Stephanie LeManager (2012) 'The Aesthetics of Petroleum, after 'Oil!'' American Literary History

⁶ "...it could be argued that oil is a uniquely occluded substance... its pervasiveness, its presence, everywhere, perhaps singularly christens its position as 'hidden in plain sight'" Imre Szemen and Maria Whiteman (2012) 'Oil Imag(e)ries: Critical Realism and the Oil Sands' Imaginations: Journal of Cross-Cultural Image Studies

⁷ Gerry Canavan (2014) *Retofutures and Petrofutures: Oil, Scarcity, Limit*, Oil Culture

Caroline Edwards (2015) Peak oil in the popular imagination, Alluvium

Graeme Macdonald (2014) 'Improbability Drives: The Energy of SF' Paradoxa

Patricia Yaeger et al. (2011) Editor's Column: Literature in the Ages of Wood, Tallow, Coal, Whale Oil, Gasoline, Atomic Power, and Other Energy Sources, PMLA

⁸ Kathleen Spencer (1983) "'The Red Sun Is High, the Blue Low": Towards a Stylistic Description of Science Fiction', Science Fiction Studies

He was relieved when they ascended to the workaday level of Oregon City again, up where the Dome shut out Sky and ocean, where the honeycombed buildings and pedbelts and shuttles reassured him of the power of mind over matter. Up here, nature did not exist. People everywhere, and the shiny things people had made.

Scott Russell Sanders (1985) *Terrarium*

It presents a techno-utopian fix to an environmental crisis, backgrounded by a reliance on alternative sources of energy and construction materials which suggests that the narrative is set in a post-oil landscape.

In terms of its architectural form, the novel appears to draw upon the work of the architect Paolo Soleri who coined the term 'arcologies' to refer to this structural separation of human and environment. In his text 'The Bridge between Matter and Spirit is Matter Becoming Spirit: The Arcology of Paolo Soleri' he echoes the conclusions of the limits to growth, citing the inevitable necessity of "structuralising" the environment.⁹ He believed that in order to thrive, humanity must direct urban development towards arcologies, which would strive to be self-sufficient.

Soleri's vision of the arcology is utopian in its ambition to be both for the good of the world outside as well as for the benefit of those within, and his designs acknowledge and celebrate the environmental support offered by the world outside the enclosure. Life inside is envisaged as being transformed, enriched by a greater awareness of the mutual dependency. By comparison, the society within the dome of *Terrarium* is entirely cut off from the world outside, constrained by both the physical limits of the dome itself and by a rigid pattern of social customs and behaviours which aims to hold humanity in a steady state condition.

Enclosure had been the only way of holding the energy slide, the famine for materials, the poisoning of the planet.

If it was halted.

Scott Russell Sanders (1985) *Terrarium*

Looking at our BREEAM criteria, sadly *Terrarium* doesn't score well in the first criteria Management, there are credits gained for responsible construction, but as humanity appears to have been offered no choice but to live in the domes, I have deducted the credits available for stakeholder consultation. In regard to health and well-being, there are credits gained for excellent internal air quality within the hermetically sealed dome although a few points are lost for natural lighting, there is mention of the artificial lights of the 'sky ballet' implying it is effectively a solid bunker.

As well as providing a perfect environment for humanity, enclosure is depicted as an act of environmental conservation, allowing the world outside the opportunity recover.

"The Earth was sick, with a disease called people. So, I helped put us in quarantine. Inside the bottle, as you liked to say so bitterly."

So, credits gained under the heading of land use and ecology, for managing the negative

⁹ "To sustain the next step in the development of sentient and reflective life... man shall have to put order to his own layer: to structuralize his environment. The second step will be the ultra-structure he will create out of such environment and himself." Paolo Soleri(1973) *The Bridge between Matter and Spirit is Matter Becoming Spirit: The Arcology of Paolo Soleri*

impact of the development.

“We mine the dumps and junk yards for metal. We dismantle the Old cities, the burned-out factories, the abandoned machinery. We haul the rockets out of their silos and the wrecks out of the ocean, melt them down. There’s plenty around to build a thousand cities or so, connect them with pipes, enclose them with domes.”

The domes themselves are constructed from the salvage reclaimed from the old world in an idealised image of material renewal and return, where the physical impact of humanity can be at least partially un-made.

This ideal of recycling has some obvious limitations as it appears that the primary material being re-used is metal, but given the technological developments hinted at I am inclined to award all credits available for use of sustainable materials, and some credits for innovation as well. Similarly, the construction waste is minimal, with recycled materials from demolition being used as aggregate in the concrete, and it would certainly get the credit for 'responding to climate change'.

Inside the domes, the movable pedways speak to a continuation of electrical power, and as this is a mass transit system in operation in a densely populated urban centre it gains maximum credits for sustainable transportation. It is implied that the power for the pedways and all other systems is sourced from solar or tidal energy systems. So maximum credits in water efficiency, and the use of renewable sources of power, although the massive air filtration systems does mean we drop a few.

Considered in terms of sustainability criteria the world of Terrarium scores an Outstanding BREEAM level, exactly the kind of sustainable development we are looking for. But, as is painfully apparent, BREEAM only measures sustainability in terms of the material and energy, it has no measure of the quality of life, the society or culture within the buildings it analyses. As Till has critiqued, it offers no critical awareness of what it is that we are sustaining.

Terrarium is a polemical novel written by an author with a passion for ecological conservation. In response it offers a vision of a future where technological fixes are liberally deployed in an attempt to sustain humanity in a radically changed Earth, to allow for a critical reflection on the nature of the society which has been sustained and what has been lost.

At least we can salvage the steel and copper, the aluminium and chrome, the bits of Terra tied up in the old places... Brick streets and wooden houses are all that remain...

In its depictions of recycling, it reflects on notions of scarcity in terms of geographical and social distribution by suggesting that there is stuff enough already, that the material fabric of architecture is sufficient, it just isn't efficiently or equitably deployed. It also makes clear the limits of what can be un-done and in doing so highlights the responsibility we carry for each product we make.

The radical cultural shift which has accompanies the change from oil to tidal forms of energy in the novel is symbolically addressed in the new forms of mapping, where the cities are shown as a schematic connected by sealed tubes and evenly distributed on a grid.

At work, Phoenix preferred using a schematic map of the continent... superimposed on a grid of cyber coordinates, and behind it all lurked the shadowy outline of North America.

Here then the occluded quality of oil as an energy system has been extended to include the entire world outside of the dome, and it brings into sharp relief the acts of unseeing which are uncritically practiced as part of contemporary petro-modernity.

While Terrarium considers the construction of domes to protect us from environments of our own making, in the Mars trilogy the dome protects a bubble of earth-like atmospheric conditions, else-where as well as else-when, it is a society on a world which has never had oil.

On the approach to Mars, the first settlers begin to discuss their political and social distance from the governments and conventions of Earth.

As for the insides, perhaps mostly open. Everyone should have their rooms, sure, but these should be small. Set in the rim perhaps, and facing larger communal spaces... There. This is architectural grammar that would say 'All equal.'

And thus credits are gained in the management criteria for excellent stakeholder engagement processes, although sadly as a 'speculative project' we do drop three credits. As a scientific community, an idealised meritocracy, one of the settlers proposes that the circular form of the geodesic dome would structuralise a commitment to equality.

The geodesic dome was developed by the architect and engineer Buckminster Fuller, whose text *Operating Manual for Spaceship Earth* detailed his ecologically driven practice, predicated on his awareness of the finite limits of resources but also his technological optimism in the development of new technologies.¹⁰ Fuller envisaged domes over entire cities, like his plans for East St Louis, minimal structures which would establish a common temperate environment inside, sheltering the mass of humanity in the most efficient way possible. It was conceived as a collective form of architecture, a material expression of the hopes of techno-utopianism.

However, landing on Mars, expediency is prioritised over social and architectural revolution, and the settlement is buried rather than domed to protect them from radiation exposure. The criteria for Land Use and Ecology means that credits are awarded for the development of increased biodiversity on the site, although one is lost as the land has not been previously developed.

As described by Robinson, the existing landscape of Mars is radically impoverished, the first one hundred colonists have only access to equipment which was sent ahead of their arrival and a limited amount of bamboo which they are able to grow, but all other building materials must be dragged out of the regolith.¹¹

¹⁰ Buckminster Fuller (1969) *The Operating Manual for Spaceship Earth*

¹¹ "One thing about Mars is that it's a radically impoverished landscape. You start with nothing – the bare rock, the volatile chemicals that are needed for life, some water, and an empty landscape. That makes it a kind of gigantic metaphor, or modelling exercise, and it gives you a way to imagine the fundamentals of what we're doing here on Earth." Kim Stanley Robinson quoted in Geoff Manaugh (2018) *Comparative Planetology: An Interview with Kim Stanley Robinson*

For the engineer in charge of the construction, it is only when she returns from the relatively untouched landscapes beyond, that she becomes aware of the moral and emotional impact of these extraction processes.

It had the disordered, functional, ugly look of Vanino or Usman or any of the Stalinist heavy industry cities in the Urals, or the oil camps of Yakut. They rolled through a good five kilometers of this devastation.

They are an immediate manifestation of the change brought about by colonisation, a visceral mark carved into the landscape which foreshadows the subsequent transformation of the planet. They use the extracted material to create concrete, brick and glass and arranged rooms in functional barrel vaults. But it takes this shift in perspective to prompt them to start using glazes and tints in the brick, to lay mosaic floors, to find the potential for beauty in this return to traditional building techniques.

“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.”

These moments of architectural art are subsequently found across the settlements, a symbolic making of home in and from the alien environment.

While there are a large number of potential credits dropped due to the extensive mineral extraction required for the development of Underhill, as well as the nuclear waste generated by the extraction machinery, almost as many are gained back for 'material optimisation' and highly efficient use of local resources. Against these brick, timber, stone and glass enclosures, the first major city built on the surface of Mars sits under a transparent dome.

It was the first town of any size to be built free-standing on the Martian surface; all the buildings were set inside what was in effect an immense clear tent, supported by a nearly invisible frame.

But as the context around it has changed, its symbolic value has shifted, from a statement of social equality one of aspiration. This movement out from under the planetary surface means that the Mars development accrues a few more credits for natural daylighting, but the continued lack of outdoor spaces makes some of the points a continued impossibility, and sadly the previously excellent building security rating drops.

...an outer membrane of piezoelectric plastic generates electricity from the wind. Then two sheets hold a layer of airgel insulation... There was faint white lettering printed on the plastic: Isidis Planitia Polymers.

The dome is made from a 'piezoelectric plastic,' a molecular manipulation of the materials extracted from the regolith and branded with the name of the manufacturer. It is a symbol of power in all respects, able to generating electricity from the winds which buffet the outside of the dome surface. While the colonists had initially discussed the use of wind turbines, they have up until this point been predominantly reliant on the nuclear reactors which were shipped ahead of them.

This change to wind power gains the development a significant number of credits for use of on-site renewal energy sources. Although, I have docked a few credits for CO2 emissions as this is almost encouraged as part of the terraforming process. And while there are extensive facilities which use power including a swimming pool, they are all highly energy efficient, so no credits lost there.

When tallied up the development of Mars would get a Very Good BREEAM rating, perhaps not an ideal model of sustainable development but certainly meeting the standards imposed by most local authorities in the UK. But the flattened reading of BREEAM again fails to take into consideration the social, cultural or moral implications of the shifting attitudes to scarcity and abundance which accompany the sustaining of life on Mars. These are brought into focus with the depictions of the mining colonies, strip mines operated by commercial conglomerates who ship material back to Earth.

Wreaking such havoc just to strip away metals, destined for Earth's insatiable demand.

They act as a point of comparison between resource as a commodity extracted from an abundant source, and the extraction undertaken by the colonists to meet communal necessity in a condition of material scarcity. It provides an opportunity to look beyond sustainability, to critically reflect on scarcity as a cultural concept rather than an absolute measure, conditional on the subjective notions of social need or corporate greed.

Across the trilogy, Robinson charts how the economic, spatial and political structures of this new world are intimately connected with the changing landscape of Mars itself, and in particular the attitudes towards terraforming which have been analysed by scholars such as Ursula K. Heise, Robert Markley and Chris Pak whose extensive work on the subject I would highly recommend.¹²

Frank reached out and pushed at the inner membrane... He poked the tent wall so hard that he pushed out the outermost membrane, which meant that some of his anger would be captured and stored as electricity in the town's grid.

Before this aeroforming is complete, the dome acts as a tangible barrier between the human and the alien landscape it also establishes a dynamic of mutual dependency, expressing the fragility of their situation, and their reliance on that same hostile environment for the power which sustains them. Through this material, the systems of power visibly enfold themselves around the city of Nicosia. It provides a visceral reminder of the layers of economic and political occlusion which prevent us from simply reaching out and poking at the edges of our petrochemical dependence.

In an age where the future design and infrastructure of urban and suburban forms are critical aspects of the climate challenge, any cultural form aiming to project and imagine

¹² Ursula K. Heise (2011) *Martian Ecologies and the Future of Nature Twentieth Century Literature*
Robert Markley (1997) *Falling into Theory: Simulation, Terraformation, and Eco-Economics in Kim Stanley Robinson's Martian Trilogy*, MFS Modern Fiction Studies
Chris Pak (2010) 'Ecocriticism and Terraforming: Building Critical Spaces', FORUM: University of Edinburgh Postgraduate Journal of Culture & the Arts
Chris Pak (2016) 'Terraforming and the City', *Ecozon@: European Journal of Literature, Culture and Environment*

how (and where) we live in a radically different or altered way from a present era of unsustainability becomes ever more essential.

Graeme Macdonald (2014)

Improbability Drives: The Energy of SF

Paradoxa

These novels might offer the radically different depictions of future design and infrastructure called for by Macdonald, but they do so in futures replete with imagined technologies that almost seamlessly replace the role of oil and petrochemical derivatives. These worlds excel when considered against the criteria set out by the UN for sustainable development. Judged against this metric which has been developed by advocates of sustainability they should provide reassuring visions that the continual improvement of the efficiency of 'stuff will see us through to a post-oil future. But while they present us with a series of techno-utopian fixes to the absolute limit of oil, as we live through the pages of these novels and look up at the dome above us, we gain an awareness of the systems of energy and material production behind these architectural products.

Dismissing technological problems as already overcome leaves with no alternative but to consider the socio-economic embeddedness of our own petrochemical dependence. They resist deferring consideration of life without oil to an indeterminate future by inhabiting that position of futurity. While I know that doing a BREEAM assessment on a fictional world is a surreal and ridiculous exercise, it is perhaps less so when you consider that it must be undertaken for all architectural projects while they too sit as imagined futures on a drawing board. For architects, sf offers an opportunity to shift our focus from sustainability to scarcity, to look beyond the development of new materials or energy efficient building techniques and develop a valuable scepticism of the measurable metrics for sustainable development. From this perspective we can ask vital questions not just about how we build, or what we build with, but whether we should build at all, and perhaps start to acknowledge responsibility for the society we are constructing.