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To cite this article: Fred Scharmen (2017) Highest and Best Use: Subjectivity and Climates Off and After Earth, *Journal of Architectural Education*, 71:2, 184-196, DOI: [10.1080/10464883.2017.1340775](https://doi.org/10.1080/10464883.2017.1340775)

To link to this article: <https://doi.org/10.1080/10464883.2017.1340775>



Published online: 28 Nov 2017.



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Highest and Best Use

Subjectivity and Climates Off and After Earth

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Using the concept of the *Umwelt* from biology, postcolonial interpretations of climate change, and Judith Butler's gender and ability theory, this article argues that the creation of new environments is always the creation of a subject, maybe even a corporate, nonhuman one. Examples are drawn from the twentieth-century history of the design and occupation of human habitats in space, from Earthbound corporate architecture, and speculative urban design.

Introduction: Concerning Space

Lettuce

In August 2015 American astronauts aboard the International Space Station grew and ate their own food in space for the first time. The Veg-01 experiment, brought to the station in a SpaceX Dragon capsule, was a self-contained collapsible lettuce bed with growth medium in a "pillow" and built-in LED lighting, but mostly in the red and blue portion of the spectrum. Yellow and green light, while important to human vision and comfort, is largely ignored by plant photosynthesis. To save weight and energy—which both come at a premium off Earth—almost no light in this end of the spectrum was used to grow the lettuce. NASA's press release on the Veg-01 experiment notes that the benefits of farming in space extend beyond the use-value of food production: "Having something green and growing—a little piece of Earth—to take care of when living and working in an extreme and stressful environment could have tremendous value and impact."¹

But the same NASA statement also acknowledges that the use of this bright pink light to grow the lettuce left it looking less like "edible food" and more like "weird purple plants" (Figure 1).

Chlorophyll appears green to human eyes because green is the light color that it reflects, while

most of the rest of the spectrum is absorbed. To humans, plants appear green because plants are indifferent to green. Green light is not part of what biologist and biosemiotician Jakob von Uexküll calls the plant's *Umwelt*. For Uexküll, an organism's *Umwelt* is the set of all aspects of that organism's environment that it is capable of sensing, reacting to, and intentionally acting on.² This set is necessarily smaller than the set of all conditions within the environment itself. Besides the green and yellow light disregarded by the lettuce, the electromagnetic spectrum is wider even than the narrow portion visible to humans, extending out through infrared and ultraviolet and beyond. In Uexküll's system, different organisms can

Figure 1. Expedition 39 flight engineer and NASA astronaut Steve Swanson opens the plant wicks in the Veggie plant growth system May 11, 2015, on the International Space Station. (Image courtesy of NASA.)



share the same environment, while living in completely different subjective worlds. When humans see green plants lit by the light of our yellow-white sun, we think of nature, open space, and growth. These are things that benefit our psychological well-being, especially when we're in a comparatively small bubble of warmth and air surrounded by the vast harshness of space. The bright pink light of the efficient LED growth system takes the plants out of the human *Umwelt* and displaces that sense of calm availability that a green landscape offers. This light transfigures what was understandable as a provider of space, air, and food into something stranger. The space lettuce was eaten by the astronauts, but under the pink lights, the lettuce is shown as something that is not *for* the astronauts: this is lettuce within its own *Umwelt*.

This case of the space lettuce demonstrates that the worlds we live in are not concentric, that different aspects of the environment center on and address different types of subjects. This is as true in artificial environments on Earth as it is in space. The rolling fields we see in the sunshine are bouncing their green light back at us, and it is this that we associate with "naturalness," even though this condition is the result of construction and rejection. Agricultural landscapes, and most other places on Earth, are affected by human intervention to make them more amenable to our existence. Other writers have discussed the implications of the idea that human modifications, intentional and unintentional, of the Earth's environment have become so widespread that their effects define a new geological epoch, the Anthropocene.³

The historian and colonial scholar Dipesh Chakrabarty, in his essay "The Climate of History: Four Theses," has written about the responses to anthropogenic climate change in terms of the break between different types of human history: on the one hand, a history

of the biological species, and on the other hand, a history of capital and cultural modes. Chakrabarty sees climate change as a crisis in, to quote the title of the first of his theses, "the Collapse of the Age-Old Distinction between Natural History and Human History."⁴ Elsewhere, Chakrabarty has discussed political discourse around climate change as "the process of trying to produce this global humanity,"⁵ that is, the production of a new subjectivity around this collapsed distinction. For Chakrabarty, climate change asks us to be clear about the difference between the end of human existence and the end of Western modernism. The question of the Anthropocene and anthropogenic climate change thereby becomes a question of how the environmental qualities of a world encourage the existence of certain subjectivities and preclude the existence of others. A planet with an atmosphere that is, on average, 2°C warmer than it had been in recent history challenges assumptions about who the planet is *for*, by revealing other *Umwelts* with other ways of being within them.

An environment like the International Space Station is almost totally constructed to suit human needs. The Earth's recent temperature, humidity, atmospheric composition, and background radiation levels have all helped produce humans as a biological species within it, while on the space station, we have in turn constructed a mechanical reproduction of these aspects of the environment conducive to human life. Here, more than anywhere else, we have made an image of our own *Umwelt*. Every parameter of the environment here is explicitly debated, designed, and built. When climate change on Earth is reframed as a question about which subjectivities the planet's environment is for, we can see that the production of entirely artificial environments in space and elsewhere foregrounds this question even more directly. The production of specific subjects is hard-built into every

aspect of these habitats. If the project of the creation of new human worlds in space will proceed, there should also be a discussion about who these worlds are *for*.

Home on Lagrange

In the 1970s, it became clear that the initial period of human exploration in space was ending. The next period would be more concerned with the problems of long-term inhabitation. The United States and its space program had beaten the Soviet Union to the moon. Beginning in 1971, though, the Soviets began to launch a series of regularly occupied space stations under their Salyut program. Instead of pushing ever farther out into an uninhabitable satellite world, ships sent to space would, for the first time, have a habitable destination waiting for them. The Americans launched their first station, Skylab, in 1973, but it was only occupied for less than nine months. Meanwhile the Salyut program lasted until 1986, when its unlaunched hardware was converted into the core of the new modular Mir space station. The final piece of the Salyut system, a module designated DOS-8, became the service block for the International Space Station and is expected to be in orbit until at least 2020.⁶

At the same time that the Soviet Union was establishing human-habitable, semipermanent environments in space, NASA had begun to speculate about taking space living to the next scale. Beginning in 1975, NASA co-sponsored a series of studies in Silicon Valley that brought artists, planners, engineers, and architects together to design large artificial worlds in space for thousands, and eventually millions, of people.⁷ Previously existing schemes had conceived of space-based construction as the connection of series of rooms and modules, launched one by one from Earth. The participants in the NASA summer studies, directed by Princeton physicist Gerard K. O'Neill, designed miles-wide

spheres, cylinders, and toruses, built in orbit from material mined on the moon.⁸ These were to be located at the Lagrange points, areas where the gravitational interaction between the Earth and Moon allowed for stable orbits. Spun for artificial gravity, the habitats would have wide-open surfaces inside, ready to be filled with new buildings and landscape.

In order to create the design specifications for a model habitat for 10,000 people, known as the Stanford Torus, architect Patrick Hill of California Polytechnic State University in San Luis Obispo consulted reference texts in urban design, including Hans Blumenfeld's *The Modern Metropolis: Its Origins, Growth, Characteristics, and Planning* (1967), and Harland Bartholomew's *Land Use in American Cities* (1955). The study report draws heavily on the recommendations of Joseph De Chiara and Lee Koppelman's *Urban Planning and Design Criteria* (1975).⁹ As in the case of the space lettuce, this design study also recognized the psychological benefits of access to "green and growing" things. In a section titled "Psychological and Cultural Considerations," the report authors specify this need:

Something must exist which grows. Interactive processes generate new patterns which cannot be inferred from the information contained in the old state. This is not due to randomness but rather to different amplification by mutual causal loops. It is important for each person to feel able to contribute personally to something which grows, that the reality often goes in a direction different from expectation, and finally that what each person takes care of (a child, for example) may possess increased wisdom, and may grow into something beyond the individual in control. From this point of view, it is important personally to raise children, and to grow vegetables and trees with personal care, not by mechanical means. It is also desirable to see plants and animals grow, which is facilitated by a long line of sight.¹⁰

The authors note that a survey of fifty-three cities in the United States turns up an average of 18 square meters of urban park space per person, and that De Chiara and Koppelman's text recommends 14 square meters. The authors then note that the design study will aim for only 10 square meters of park per person "because the space habitat contains agricultural areas that can be in part used as open space."¹¹

In another section of the report, on human nutritional requirements and agriculture, some of the characteristics of this growing space are sketched:

The crops are grown in a lunar soil (ref. 4) about 0.3 m deep. This soil is made into a lightweight growth matrix by foaming melted rock. The yields are greater than those achieved on Earth because of improved growing conditions and the ability to grow crops on a year-round basis. The higher levels of carbon dioxide, improved lighting, and temperature and humidity control increase productivity to approximately 10 times that of the typical American farm.¹²

The ability to fine-tune the environmental conditions of these agricultural areas to the precise *Umwelt* of various kinds of productive plants is expected to dramatically increase crop production. Just as the urban designers do above, the experts laying out the farms in the habitat start with optimistic assumptions and round up their numbers from there. "Crops were estimated assuming a yield double that of the world record for that crop."¹³ With shorter seasons, four harvests per year, and the total elimination of "pests," the authors speculate that yields up to 40 times what might be expected on Earth could be possible from this plant paradise, and they do their space planning accordingly. But with 24-hour-long bright sunlight, high heat and humidity, and, in some cases, atmospheres supercharged with carbon dioxide, these will not be

pleasant green parks within which to take a stroll and escape for a moment the stress of living in a hostile environment, despite the optimism of the urban planners. Paradoxically, in order to optimize for one kind of human need—food production—it is necessary to produce a world that is for the plants, but not legible or usable by humans who also have other needs, like psychological access to "something green and growing."

Available ground surface, like the energy and room given over to the space lettuce on the International Space Station, was going to be scarce and expensive here. The literature surrounding this project is full of debates about what the density of the habitats would look and feel like. The NASA summer study report invoked "some small French villages"¹⁴ as a reference and pointedly contrasted the character of the space with Earthbound cities: "Emerging from the elevator your fellow passengers go their various ways as you enter a busy community without skyscrapers and freeways; a city which does not dwarf its inhabitants. The human scale of the architecture is emphasized by the long lines of sight, the frequent clusters of small fruit trees and parks, and the sense of openness produced by the broad expanse of yellow sunlight streaming down from far overhead."¹⁵

Stewart Brand, the publisher of countercultural resource guide *The Whole Earth Catalog*, financially supported early efforts to clarify the design of these habitats. He published some of the work from the NASA summer studies in his second magazine, *CoEvolution Quarterly*, and solicited responses from other cultural figures and from the general public.¹⁶ One of his respondents, Steven Baer, designer of the Drop City commune's dome houses, was not convinced that the small fruit trees and parks would be forthcoming: "Instead, I see acres of air-conditioned Greyhound bus interior, glinting slightly greasy railings, old rivet heads needing paint—I don't hear the surf at

Figure 2. Right, above: Cylinder endcap view with suspension bridge, Don Davis, 1975. (Image courtesy of NASA Ames Research Center.)

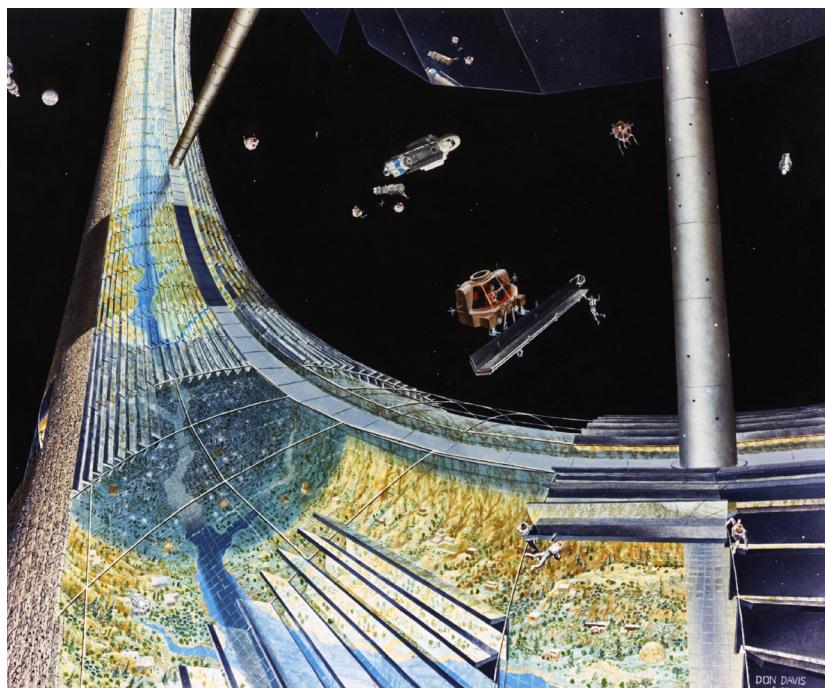
Figure 3. Right, below: Construction along the Stanford Torus Rim, Don Davis, 1975. (Image courtesy of NASA Ames Research Center.)

Carmel and smell the ocean—I hear piped music and smell chewing gum. I anticipate a continuous vague low-key ‘airplane fear.’”¹⁷

Baer’s reference to Carmel comes from a painting that Brand had published, by science illustrator Don Davis, showing a view of a city on a bay with a suspension bridge (Figure 2). The foreground of the painting is in a woodsy meadow, with a family playing in a mountain stream; the background shows the view out of the large late-model space habitat’s window, of another structure in the void of space outside. On his website, Davis writes about this painting:

Here is what is probably my most widely seen pre digital painting, my “Bay Area” derived interior for a giant cylindrical habitat design. It was painted this way under the direction of space colonization popularizer Gerard O’Neill himself, who related a recent impression of the vantage point from Sausalito being an excellent scale reference for a possible setting inside a later model cylindrical colony. ... I deliberately wanted to imply the challenge of trying to transplant a workable ecosystem to a giant terrarium in Space. Most other depictions are dreary mega-shopping mall like structures filling the available volume.¹⁸

Baer’s comment is relevant to these paintings in at least one other way—the geometry of the cabin in the scene would not be out of place among Baer’s Drop City dome homes. In another painting for the NASA summer study, Davis showed the interior of a Stanford Torus filled with Drop City’s prairie desert landscape, dotted with individually unique small structures, including a Buckminster Fuller–style geodesic dome (Figure 3). In conversation,



Davis acknowledges the deliberate countercultural references to DIY construction and communal living that this painting was intended to make.¹⁹ On his website, in an annotation for this Stanford Torus view, Davis says, “The interior is shown primarily hollowed out and heavily planted. Most other depictions show the colony crammed

with levels of high density housing. Ugh.”²⁰

Davis’s description might apply to the renderings made for the summer study by another artist—architect and illustrator Rick Guidice (Figure 4). Guidice’s paintings show higher-density urban living, with the kind of terraced megastructural residential buildings chronicled in

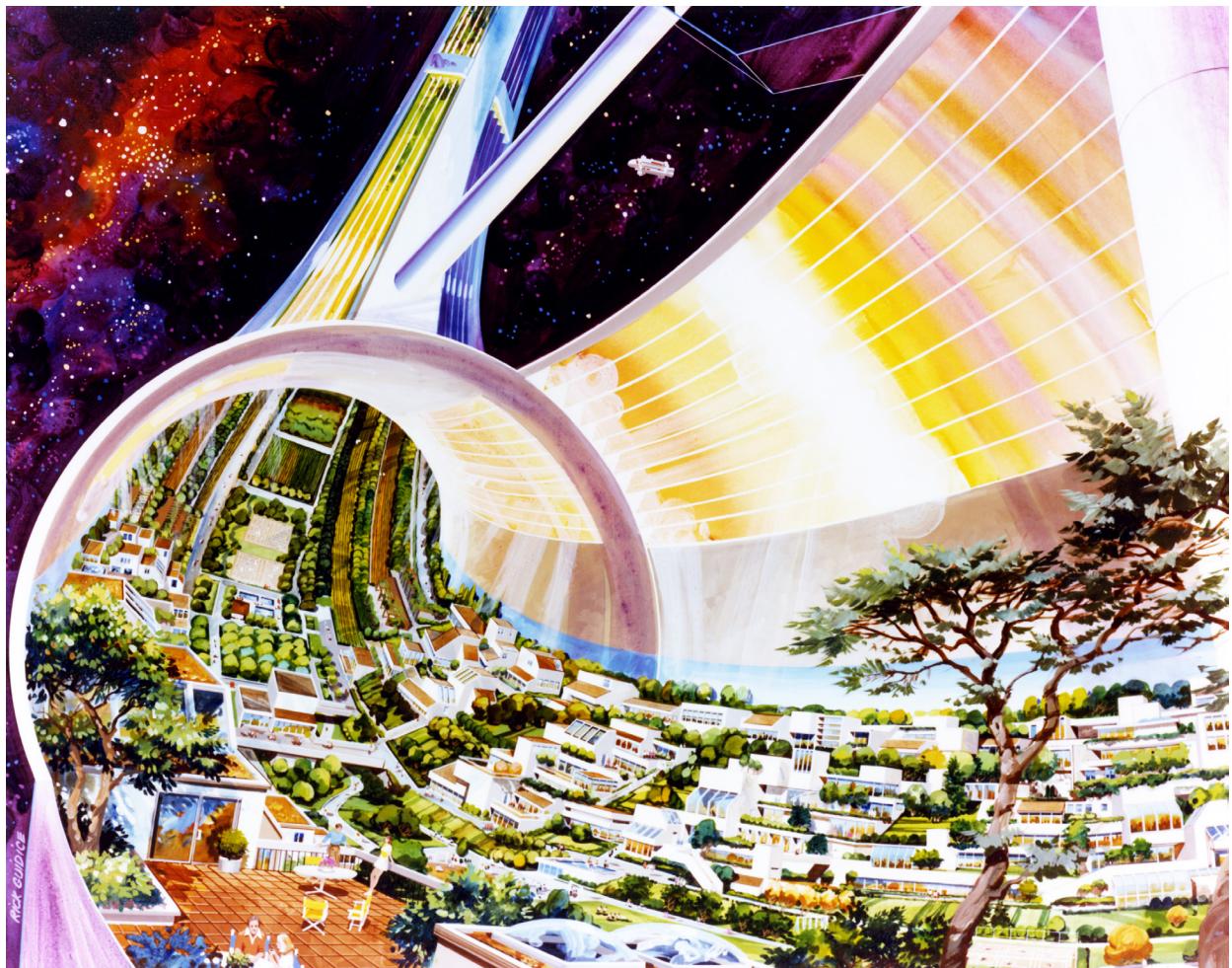


Figure 4. Stanford Torus cutaway view, exposing the interior, Rick Guidice, 1975. (Image courtesy of NASA Ames Research Center.)

Reyner Banham's "Megastructure: Urban Futures of the Recent Past."²¹ In Guidice's Stanford Torus view, the fruit trees and parks are present, along with bike paths, ball fields, and people lounging on the balcony terraces. In the distance, we can see an agricultural area, but we can't see the giant doors that would close off this farm in order to create the hothouse atmosphere specified by the summer study's agricultural engineers.

Guidice's paintings are closer to those in another urban design reference used in the summer study, *Compact City: A Plan for a Liveable Urban Environment* (1973), by George B. Dantzig and Thomas L. Saaty.²² This book described a scheme

for a new Earthbound city with 250,000 residents, in the shape of a giant ring, with stacks of terraced housing and offices around and inside it. The drawings in *Compact City*, by architect John Lange, show landscaped interiors with plants growing under artificial light. These are reminiscent of drawings made by summer study architect Patrick Hill, who was also a colleague of Lange's at Cal Poly (Figure 5). Lange and Hill's views seem meant to merely document and illustrate a condition; they were never used persuasively as book covers or, as Davis and Guidice's paintings were, shown to Congress. These drawings are more clear about depicting the "shopping mall gone mad"²³ designed densities in the habitats that Davis feared and contested with his paintings of Californian landscapes in space.

Communications scholar Fred Turner has linked the impulse behind the design of these habitats, especially as promoted by Stewart Brand, to the broader notion of the frontier. In his book, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (2006),²⁴ Turner traces a line from the back-to-the-land movement in the 1960s, which was supported by Brand's *Whole Earth Catalog*, and found its most well-known manifestation in Baer's Drop City, to contemporary digital frontiers in cyberspace. The period in which Stewart Brand is associated with Gerard O'Neill and the summer studies is a bridge between these modes, in which the frontier is in outer space. O'Neill's supporters, at one point, composed "Home on Lagrange," to the tune of "Home on

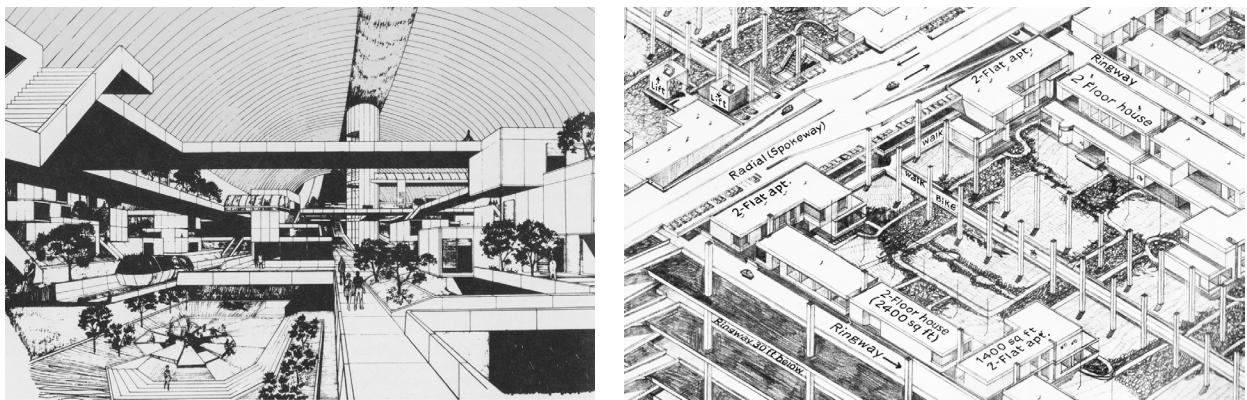


Figure 5. Above, left: View of Stanford Torus Housing, Pat Hill, 1975. Right: Dense city, detail of a residential section, John Lange, 1974. (Collage by Fred Scharmen.)

the Range.” Carl Sagan called the summer study proposals “a kind of America in the skies.”²⁵ O’Neill titled his 1977 book, lavishly illustrated with Guidice and Davis’ paintings, *The High Frontier*. The location where the summer design study took place, the NASA Ames Research Center, is next door to the headquarters for Google and other Internet companies in Silicon Valley. Like cyberspace, though, this was not a frontier that was simply sitting there, as if waiting for some future America to occupy it. This frontier would have to be built.

Designing Populations

No matter whether this new space would be more like a Greyhound bus, a prairie commune, a megastructure, a French village, or a shopping mall, each of these would invite, and indeed produce, a specific type of human subject as occupant. Baer’s notional alienated space habitat visitor, a victim of “airplane fear” in the endless bus terminal, Guidice’s young couples taking their ease and their coffee with views from the terrace, and Davis’s hippie family in the mountain stream are all human subjects existing in a way that’s inextricable from the designed *Umwelt* of their environment. Philosopher and gender theorist Judith Butler has written about how the design of different environments privileges and produces certain kinds of subjects with certain kinds of abilities and presentations. Butler

points out that in some territories, streetscapes exclude people who use devices for walking, and in other places, social norms exclude people with marginalized gender identities. “Let’s talk about this: Which environments make it possible for you to take a walk?” Butler asked artist and activist Sunaura Taylor, as they both navigated the streets of San Francisco, on foot and with a motorized wheelchair, in the 2009 philosophy documentary *Examined Life*.²⁶ What sort of person would these space habitats invite and produce? Novelist and environmental activist Wendell Berry speculated about this when he responded to Stewart Brand’s call for debate on the summer study work:

Mr. O’Neill predicts readily that his scheme will promote diversity and freedom. But he neglects to consider that the machine is already a renegade concept that sees people as spare parts, and uses them as such. Exactly how, one wonders, is this to be corrected by building an even bigger machine and causing people to live inside it, in absolute dependence on it? What, exactly, would be the effect of a completely controlled environment on human character and community? What, exactly, would be the influence of space colonization on earthly political and social forms? Mr. O’Neill does not know, and he has no way to know.²⁷

There is ample precedent in the history of human space occupation for Berry’s concerns. Within NASA, astronaut selection criteria

has become more open since the inception of the American space program, but it originally required a background in regimented military service from all candidates. As Nicholas de Monchaux details in his book *Spacesuit: Fashioning Apollo* (2011), the sizes and weight of the suits and vehicles influenced the physical characteristics of the selected members of the astronaut corps, just as much as human needs influenced the specifications of the hardware. This reciprocal relationship—between the design and production of subject and environment—almost extended, in certain speculative proposals, to the complete genetic engineering of future space explorers.²⁸

NASA’s first space station, Skylab, had amenities designed in consultation with industrial designer Raymond Loewy. Loewy designed space for relaxation, and, most famously, made the suggestion to the engineers building the station that they should include a window near the dinner table.²⁹ The first crew, however, arrived to an uninhabitable interior. The heat shield and a solar panel had been damaged. The interior of the station had become intolerably hot and lacked adequate electrical power. They were able to return the interior air to human habitable levels by deploying a makeshift heat shield and performed a space walk to fix the solar panels and regain power. Their training had prepared them to function during emergencies that threatened their bodily existence in space’s hostile environment.

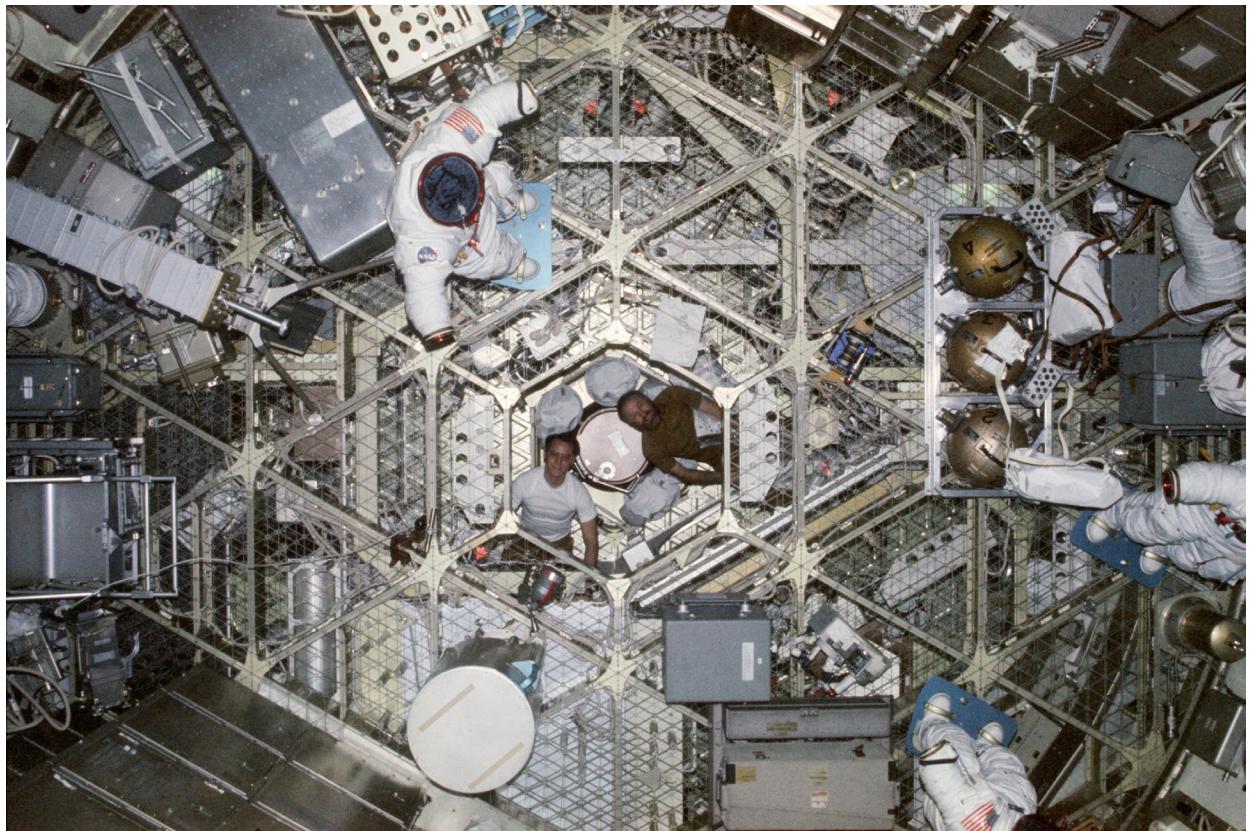


Figure 6. Gerald P. Carr and Edward G. Gibson look through the length of the station from the trash airlock, Skylab 4, 1974. (Image courtesy of NASA.)

The same kind of training and drilling created a different set of intolerable conditions, though, for the third and final crew. Frustrated by the load of closely scheduled activities, and the lack of autonomy that constant expectations from Mission Control left them, the third crew revolted and took an unscheduled day off. In a statement to ground control that echoes Butler's language about the existence of bodies in space, mission pilot William Pogue said, "When we [are] oppressed bodily from one point in the spacecraft to another with no time for mental preparation, let alone getting the experiment ready, there's no way we can do a professional job!"³⁰ The crew spent part of their time off gazing out of Loewy's window. Finding that they were unable to exist within the conditions in which they found themselves, they had pushed back against becoming "spare parts" in the machine that

Wendell Berry warns Stewart Brand about (Figure 6). This act effectively redefined their existence as subjects in the astronaut program; none of these three crew members ever got a chance to fly in space again.³¹

The physical and organizational atmospheres of Skylab determined the existence of certain biological and institutional subjects. Even on Earth, seemingly simple things like air temperature and environmental control systems can become fraught with overdetermination. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers produces and updates a document, *ANSI/ASHRAE Standard 55, Thermal and Environmental Conditions for Human Occupancy*, that regulates the atmosphere of most kinds of buildings.³² This document relies on a standard developed by Danish scientist Povl Ole Fanger that measures human reaction to conditions in terms of Predicted Mean Vote (PMV), and the Predicted Percentage Dissatisfied (PPD).

These numbers represent statistical modeling of "satisfaction" that collapses several factors—like metabolic rate, clothing coverage, and air movement—into predictions about the judgment of groups of model people. A 2015 paper in the journal *Nature Climate Change* showed that this formula, developed in the 1960s, used the metabolic rate for typical men, which could be up to 150 percent higher than the typical metabolic rate for women.³³ When these false assumptions are hard baked into building code, women feel uncomfortably cold in office environments. Because of divergence within cultural and biological norms, these metrics might indicate that the conditions within a given room were fine, even if the split between people who might think the room was too cold and those who might think it is too hot leaves no one left in the middle who thinks conditions are just right. By attempting to please everyone and solve a problem for a virtual ideal subject, this kind

of exercise might exclude all of the actual subjects present.

In the summer study habitats, every aspect of the internal environment would be designed. The heat, humidity, light levels, atmospheric composition—even the amount of artificial spin gravity—would address not just the *Umwelts* of plant and animal subjects, but could determine the potential existence of different kinds of human subjectivities too. For Gerard O'Neill, as a proponent of the idea, this was a feature, not a bug. No longer would large government systems and cultural modes have to attempt to please all people, and in doing so leave so many dissatisfied. The variety and possibility represented by different habitats in O'Neill's scenario would allow fractured human cultures to self-segregate. In one part of *The High Frontier*, O'Neill sympathizes with utopian communities who have seen the drug use and social strife of the 1960s taking place outside of their worlds and speculates about how the inhabitation of space might offer new ways to opt out:

In space, where free solar energy and optimum farming conditions will be available to every community, no matter how small, it will be possible for special-interest groups to "do their own thing" and build small worlds of their own, independent of the rest of the human population. We can imagine a community of as few as some hundreds of people, sharing a passion for a novel system of government, or for music or for one of the visual arts, or for a less esoteric interest: nudism, water sports, or skiing. Of the serious experiments in society-building, some will surely be failures. Others, though, may succeed, and those independent social laboratories may teach us more about how people can best live together than we can ever learn on Earth, where high technology must go hand-in-hand with the rigidity of large-scale human groupings.³⁴

Aside from the potential of "new artistic specialties, like weather design and creative ecology," it is the design of new social and cultural systems, custom suited for each potential human subjectivity, that is the selling point for O'Neill's scheme, especially in a 1970s America torn apart by resource and culture wars. Carl Sagan's remark about "America in the skies" was in response to Stewart Brand's prompt, and published in Brand's compendium on the topic, *Space Colonies* (1977). It was part of Sagan's speculation about the same potential for diversity that O'Neill sees in the concept. In his full response, he also speculates about the use of the word "colony" that comes up often around these proposals:

I think "Space Colonies" conveys an unpleasant sense of colonialism which is not, I think the spirit behind the idea. I prefer "Space Cities." One of the many virtues of the Space City proposal is that it may provide the first convincing argument for extensive manned spaceflight. The earth is almost fully explored and culturally homogenized. There are few places to which the discontent cutting edge of mankind can emigrate. There is no equivalent of the America of the 19th and early 20th centuries. But space cities provide a kind of America in the skies, an opportunity for affinity groups to develop alternative cultural, social, political, economic and technological life-styles. Almost all the societies on the earth today have not the foggiest notion of how best to deal with our complex and unknown future. Space cities may provide the social mutations that will permit the next evolutionary advance in human society. But this goal requires an early commitment to the encouragement of cultural diversity. Such a commitment might be a very fitting Bicentennial re-dedication to what is unique about the United States.³⁵

For Sagan, space populated with O'Neill's habitats is partly characterized by the notion of the melting-pot, and partly defined by the idea of survival-of-the-fittest. The America in the skies is a place where hybridity and "mutation" might—accidentally or on purpose—produce new models of living that will deal better with the future. Sagan's America in the skies is perhaps best illustrated by one of Rick Guidice's paintings (Figure 7). The interior of a Bernal Sphere space habitat is shown in the background of an interracial cocktail party scene. A green landscape dotted with small villages curves up and around the viewpoint; the architecture is a comfortable mix of vernacular and contemporary elements. There are boats in a river and a woman is piloting a glider through the zero-g center axis of the habitat. But the party guests are ignoring all of that. They present as white, Latino, and, most prominently, a black woman with an afro. They are a mix of young and middle-aged happy individuals, too absorbed in one another's presence to notice the view. When asked about this painting in an interview, Guidice mentioned his previous experience as a commercial illustrator and said that he had used his large collection of reference magazines to deliberately make a diverse crowd, so that many types of people could picture a scene like this in their potential future.³⁶

In the summer study report, the authors directly address the implication that the creation of a closed, artificial, fine-tuned habitat environment also entails the creation of a human subject. This passage addresses the ideal subject in terms that are also explicitly American—productivity:

It is not usual to think of human population as something to be designed. Nevertheless the numbers, composition, age and sex distribution, and productivity of the colonists bear importantly on the success of the project and on the creation of a suitable design.



Figure 7. Bernal Sphere interior, including human-powered flight, Rick Guidice, 1975. (Image courtesy of NASA Ames Research Center.)

being colonized; and the term reminds us of things that went badly and went well in previous colonizations,” in Brand’s view, since space is presently uninhabited. Brand’s vision is colonization without displacement, all of the upside, none of the down, and with benefits accruing to the home countries. As he says, “If we’re lucky we may enact a parallel with what happened in Europe when America was being colonized. Intellectual ferment—new lands meant new possibilities; new possibilities meant new ideas. If you can try things you think up things to try.”³⁹

For scholars of postcolonial theory, colonialism is explicitly connected with the production of certain kinds of subjects, the re-creation of certain others, and, when necessary, the suppression and elimination of still more. Displacement, in the form of removal or genocide, is only one aspect of the process of colonization.⁴⁰ Even though there is no one in space right now to displace, the project promoted by O’Neill is involved in the assumed production of “Space natives”—the productive, urban, capitalist, Western technological subjects that overwhelmingly dominate the narratives and imagery here. The space natives are Californian. Elsewhere in Brand’s book, O’Neill says directly that his scheme is not for everyone: “If the new option is taken, it would be naive to assume that its benefits will be initially shared equally among all of humankind. The world has never worked that way, and since people do not change there is no reason to suppose that it will work that way in this case.”⁴¹ Brand is correct that the project here is a colonial one, but not for the reasons he thinks. If the environment is designed, then the population is designed. The space natives cannot be produced here without a kind of displacement in advance, excluding or reshaping subjects through the creation of a particular techno-social *Umwelt*.

The study had to consider who should be the colonists, how many there should be, what skills they must have, and how they should organize and govern themselves. The alternatives are numerous and the grounds for choosing between them not as definite as for the more concrete problems of engineering, but it was possible to make what seem to be reasonable choices based on the goals of having in space permanent communities of sufficient productivity to sustain themselves economically.³⁷

Along with the resourceful frontier subject, the alienated urban subject, the contented suburban subject, and the cosmopolitan American melting pot subject, we now have the economically productive subject functioning within capitalism introduced into the space habitat. Despite the optimism of Sagan and O’Neill, hoping to see hundreds of new social and political forms blossom, the NASA report expects current forms of ground-based governance and economics to be reproduced in orbit, newly clarified and refined. This is the political parallel to the difficult contradictions being worked out in the renderings of architecture and urban design. De Witt Douglas

Kilgore of Indiana University, in his book *Astrofuturism: Science, Race, and Visions of Utopia in Space* (2003), has called the paintings produced for O’Neill’s project the “domestication of space,” normalizing the unfamiliar environment and technology with suburban tropes.³⁸ Will the cities and economic systems of the future respond to the stresses and novelty of living in constructed environments within a hostile void with bold experimentation, or nostalgia for the recent past? Like the environment itself, the question here is about what type of subject would have to be produced.

Colonizing Space

Carl Sagan wasn’t the only one uncomfortable with the term “Space Colony.” In the book *Space Colonies*, both O’Neill and Brand mention that government agencies are hesitant to use that phrasing to describe the project. Stewart Brand addresses this discussion of terminology head on: “Speaking of terms, the use of the term ‘Space Colony’ has been expressly forbidden by the US State Department because of anti-colonial feelings around the world.” Brand goes on to say that in his conversations, he’ll continue to use “colony” anyway, and besides, “this time there’s a difference in that no Space natives are

O'Neill's speculation about the inhabitation of space began with a question he asked his students in a special topics physics seminar at Princeton: "Is the surface of a planet really the right place for an expanding technological civilization?"⁴² In O'Neill's recollection, the answer, after studying resources and trends, was "no," and the design of new surfaces in what Brand called "FREE SPACE" commenced. This narrative from O'Neill suggests something more subtle about the implied subject of space colonization, that it might not even be human at all. O'Neill sets up a relationship between surfaces and civilizations, specifically a civilization consumed with growth and technology. Just as is implied by the NASA report's focus on designing the productivity of the population, here we can see that the new surfaces in the space colonies are surfaces for capitalism. The subject produced by the artificial environment is not a human person but a corporate person. As Brand writes,

One thing that impresses me about the Space environment is that, hostile as it is to us pulpy organisms, it is wholly benign for electronic and mechanical machinery, much better for them than this corrosive, weighty Earth's surface. An engineering friend of mine, [sound and new media artist] Michael Callahan, used to speculate that the machines have been longing for years to get into Space. They're using us to get there and when they've succeeded they'll throw us away. Or, maybe they'll give us something wonderful we don't even know we need.⁴³

High orbit here, with its vacuum, freefall, and abundant materials and energy, is potentially an *Umwelt* for a regime of technological beings, more than it is for any singular human subjectivity. The symbiotic relationship implied here by Brand between human and machine, technology, or corporation is one of, to use Brand's own terms, coevolution. Coined by two biologists in 1964, the

word—used to describe the mutual interactional development of two unrelated regimes of organism—was appropriated and popularized by Brand to describe the behaviors of systems in general. In Fred Turner's book on Brand, he traces Brand's interest in systems theory from an involvement with radical social experiments in the 1960s to a career in corporate consulting for Silicon Valley technology companies during the early years of the Internet.⁴⁴

As technology companies like Google and Apple expand their campuses in Silicon Valley, near the same neighborhoods where the NASA Ames Research Center summer studies took place, they are again encountering the issues raised by the space colony project enacted there. Google's new campus proposal is designed by Bjarke Ingels Group in collaboration with Thomas Heatherwick.⁴⁵ With its renderings of terraced cafes, running tracks, and modular megastructures gathered under a glass dome, it has more than a superficial resemblance to the paintings of the Stanford Torus made by Rick Guidice here 40 years ago (Figure 8). Apple's new headquarters, a gleaming ring by Norman Foster with a private garden in the center, recalls both Dantzig and Saaty's *Dense City* and the Stanford Torus exterior painted by Don Davis (Figure 9).⁴⁶

Many of these companies are investing funding and intellectual capital in investigation into the urban design of whole new environments from scratch. Google's venture, Sidewalk Labs, uses languages of platforms and capital to describe their effort to "reimagine cities from the internet up." "Often technology solutions applied to cities have failed to solve real-world problems, and policy solutions have failed to capitalize on the full potential of technology," they posit, on their website. "To address this, Sidewalk Labs is building an integrated platform for urban innovation spanning technology, data, policy best practices, relationships, and capital."⁴⁷

Another company, ycombinator,

is actively seeking suggestions for sites for experimental cities built from scratch:

Many constraints related to where cities should be located (e.g. near rivers for trade) have changed. We now have major technologies such as smart grids, autonomous vehicles, etc. The internet itself allows for participation never before possible. Also, housing prices in many cities have become untenable and we need more housing in places people want to live. Some existing cities will get bigger and there's important work being done by smart people to improve them. We also think it's possible to do amazing things given a blank slate.⁴⁸

Ycombinator is uniquely connected to social media; one of their part-time partners is Peter Thiel, a member of Facebook's board, founder of the surveillance company Palantir, and, most recently, an adviser to President Trump. Ycombinator's first hire for their New Cities initiative was Ben Huh, the former CEO of viral meme cat picture website "I Can Has Cheezburger." Their project announcement page for the New Cities initiative, written by Adora Cheung, frames the project in terms of the liberatory potential of the environment on the subject: "We want to study building new, better cities. The world is full of people who aren't realizing their potential in large part because their cities don't provide the opportunities and living conditions necessary for success."⁴⁹

The urban ambitions of technology companies—to make new space for a new kind of person to realize their potential—reiterates the aspirations of the architectural *Umwelt* from the 1960s and 1970s. Megastructural projects promised the same kinds of customization and participation that would later be relocated to online space, while new artificial platforms and domes would seek to spatially unify new and ideal communities. Then, as now, criticism of the projects can be localized around



Figure 8. Above, left: Stanford Torus Cutaway view, Rick Guidice for NASA, 1975. Above, right: Google Campus Proposal, Thomas Heatherwick and Bjarke Ingels Group for Google, 2015. (Collage by Fred Scharmen.)

Figure 9. Below, left: Stanford Torus exterior view, Don Davis for NASA, 1975. Below, right: Apple Campus Proposal, Foster + Partners for Apple, 2013. (Collage by Fred Scharmen.)

questions about who is invited, who is produced, and who is excluded. As Butler says in *Examined Life*, “We all need certain kinds of surfaces, we need certain kinds of shoes, certain kinds of weather, and even internally we need to be ambulatory in certain ways that may or not be fully operative in all of us.”⁵⁰

A footnote on the ycombinator New Cities announcement page seems to anticipate criticism of the project: “Just to get ahead of the inevitable associations: We want to build cities for all humans—for tech and non-tech people. We’re not interested in building ‘crazy libertarian utopias for techies.’”⁵¹

This passage, which implicitly constructs “all humans” as a set that breaks down into “tech and non-tech people,” seeks to control in advance the terms with which the subjects of the New Cities are thought, before the design process even begins. The distinction—between “all humans” and “techies”—re-creates the problem of the designed, produced, and managed subjectivities from the summer study space colonization project. The lesson, underscored in the NASA Summer Study report, that something “green and growing” is necessary to demonstrate the potential subjectivities that exist outside of the present attempts to control the *Umwelt*, is lost.

Ycombinator’s corporate language also reidentifies the complicated split that Dipesh Chakrabarty says is revealed by anthropogenic climate change—between, on the one hand, humanity as a biological subject and, on the other, Western technological

capitalist civilization as a historical subject. The end of one might not be the end of both. Who is the subject? And what is that subject’s *Umwelt*? Climate change in the Anthropocene makes obvious certain background atmospheric conditions that had previously been taken for granted. For Chakrabarty, again, this foregrounds “the process of trying to produce this global humanity.” The question of how to produce artificial worlds begs the question of who they are for in the first place, and while that same “global humanity” should be the obvious answer, everywhere we look, the case is not so simple. As Chakrabarty says, “But the moment we ask ‘what should we do?’ we discover that the ‘we’ needs to be constructed.”⁵² We have the choice, as designers, to make space, here on Earth and elsewhere, an ideal place for the corporate person, expanding civilizations, tech people, lettuce, and possibly, if we can define its parameters, global humanity.

Acknowledgments

I am grateful to Kate Drabinski and Jaimes Mayhew for directing my attention to Judith Butler's work. I also want to thank Lola Sheppard and Mason White for pointing me at the work of Jakob von Uexküll, and to my colleague Samia Kirchner for pointed questions about the nature of the colonized subject. Thanks to Felicity Scott, as well, for her work and research on O'Neill's project. Special thanks to editor Doug Jackson, and to the reviewers, whose comments shaped this piece.

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Notes

- ¹ Linda Herridge, "Meals Ready to Eat: Expedition 44 Crew Members Sample Leafy Greens Grown on Space Station," NASA, August 7, 2015, https://www.nasa.gov/mission_pages/station/research/news/meals_ready_to_eat (accessed February 18, 2017).
- ² "Here we may glimpse the worlds of the lowly dwellers of the meadow. To do so, we must first blow, in fancy, a soap bubble around each creature to represent its own world, filled with the perceptions which it alone knows," Jakob von Uexküll, "A Stroll Through the Worlds of Animals and Men; A Picture Book of Invisible Worlds," in *Instinctive Behavior: The Development of a Modern Concept*, trans. and ed. Claire H. Schiller (New York: International Universities Press, 1957), 5–80.
- ³ The International Commission on Stratigraphy is currently considering a formal proposal to recognize the Anthropocene as a new geological age. Accounts of the term's origin vary, but its contemporary usage was popularized by atmospheric chemist Paul J. Crutzen, who, with coauthor Eugene F. Stoermer, proposed a start date for it in the late eighteenth century. Crutzen and Stoermer, "Have We Entered the 'Anthropocene?'" in *IGBP Global Change Newsletter* 41 (2000), <http://www.igbp.net/news/opinion/opinion/haveweenteredtheanthropocene.5.d8b4c3c12bf3be638a8000578.html> (accessed February 18, 2017).
- ⁴ Dipesh Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry* 35, no. 2 (Winter 2009): 197–222.
- ⁵ "And then you can look at the politics of climate change as the process of trying to produce this global humanity ... the moment we ask 'what should we do?' we discover that the 'we' needs to be constructed"; Dipesh Chakrabarty in conversation with James Graham, "The Universals and Particulars of Climate," in *Climates: Architecture and the Planetary Imaginary*, ed. James Graham, (Baden, Switzerland: Lars Müller, 2016), 22–32.
- ⁶ For more on the history of the idea of the space station, see Robert Zimmerman, *Leaving Earth: Space Stations, Rival Superpowers, and the Quest for Interplanetary Travel* (Washington, DC: Joseph Henry Press, 2003).
- ⁷ The results of this summer study design session were published in Gerard K. O'Neill, *The High Frontier: Human Colonies in Space* (New York: William Morrow, 1977).
- ⁸ Further summer study outcomes, with more technical information, were published in NASA, *Space Settlements, a Design Study* (Washington, DC: Scientific and Technical Information Office, 1977).
- ⁹ Ibid., 36.
- ¹⁰ "Solipsism Syndrome in Artificial Environment," in *ibid.*, 29.
- ¹¹ NASA, *Space Settlements* (note 8), 33.
- ¹² *Ibid.*, 98.
- ¹³ *Ibid.*, 114.
- ¹⁴ *Ibid.*, 24.
- ¹⁵ *Ibid.*, 90.
- ¹⁶ These responses were compiled in a special book edition of material from *CoEvolution Quarterly*; see Stewart Brand, ed., *Space Colonies* (San Francisco: Waller, 1977).
- ¹⁷ Steve Baer, in *ibid.*, 40.
- ¹⁸ Don Davis, <http://www.donalddavis.com/PARTS/SHORTBIO.html> (accessed February 18, 2017).
- ¹⁹ Don Davis, in discussion with the author, June 2015.
- ²⁰ Don Davis, *Public Domain Works Done for NASA*, <http://www.donalddavis.com/PARTS/allyour.html> (accessed February 18, 2017).
- ²¹ For a more complete discussion of the design and visual culture influences in these paintings, see Fred Scharmen, "The High Frontier, the Megastructure, and the Big Dumb Object," paper presented at the 101st ACSA Annual Meeting, San Francisco, 2013.
- ²² George B. Dantzig and Thomas L. Saaty, *Compact City: A Plan for a Liveable Urban Environment* (San Francisco: W. H. Freeman, 1974).
- ²³ Davis, *Public Domain Works* (note 20).
- ²⁴ Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).
- ²⁵ Carl Sagan, in Brand, *Space Colonies* (note 16), 42.
- ²⁶ "I mean, it seems to me that we're all supported in our movements by various kinds of things that are external to us. We all need certain kinds of surfaces, we need certain kinds of shoes, certain kinds of weather, and even internally we need to be ambulatory in certain ways that may or not be fully operative in all of us. ... Let's talk about this: Which environments make it possible for you to take a walk? What does the environment have to be like in order to support your mobility?" from Judith Butler's discussion with Sunaura Taylor in *Examined Life*, directed by Astra Taylor (Zeitgeist Films, 2009).
- ²⁷ Wendell Berry, in Brand, *Space Colonies* (note 16), 37.
- ²⁸ See Nicholas de Monchaux, "Cyborg," in *Spacesuit: Fashioning Apollo* (Cambridge, MA: MIT Press, 2011), 67–78.
- ²⁹ Charles Dunlap Benson and William David Compton, *Living and Working in Space: A History of Skylab* (Washington, DC: NASA Scientific and Technical Information Office, 1983), 133–34.
- ³⁰ "Now, I don't like being put in an incredible position where I'm taking somebody's expensive equipment and thrashing about wildly with it and trying to act like a one-armed paper hanger trying to get started in insufficient time!" as quoted in Marsha Freeman, *Challenges of Human Space Exploration* (Chichester, UK: Springer, Praxis Books, 2000), 8.
- ³¹ See "Skylab, a Glorious Forgotten Triumph," in Zimmerman, *Leaving Earth* (note 6), 48–80.
- ³² ASHRAE, *ANSI/ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy*, 2013.
- ³³ Joost van Hoof, "Building Emissions: Female Thermal Demand," in *Nature Climate Change*, 5 (August 2015).
- ³⁴ O'Neill, *The High Frontier* (note 7), 201.
- ³⁵ Carl Sagan, in Brand, *Space Colonies* (note 16), 42.
- ³⁶ Rick Guidice, in discussion with the author, August 2015.
- ³⁷ NASA, *Space Settlements* (note 8), 49–50.
- ³⁸ See De Witt Douglas Kilgore, "The Domestication of Space: Gerard K. O'Neill's Suburban Diaspora," in *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia: University of Pennsylvania Press, 2003), 150–85.
- ³⁹ Stewart Brand in Brand, *Space Colonies* (note 16), 5.
- ⁴⁰ See esp. the work of Gayatri Chakravorty Spivak. One of the first methods of colonialism is to seek out those who would speak for the least among the colonized, re-forming and re-presenting them as subjects. Spivak places this in parallel with the more acknowledged path of "recognition through assimilation" of the colonized subject. Spivak traces the example of the British colonial authorities outlawing the practice of widow sacrifice in India, by first addressing themselves to local Indian social and textual authorities that represented the women as particular kinds of victimized subjects. The subject here is represented as if for the colonial authority, allowing them to step in and assert control. Alongside this discussion of the recontextualization of the subject, Spivak further complicates the narratives by building a different historical-textual context around the practice, as it would have existed within and for the precolonized culture itself. These other

contexts don't offer answers but instead more refined questions about the subject's constitution:

"Between patriarchy and imperialism, subject-constitution and object-formation, the figure of the woman disappears, not into a pristine nothingness, but into a violent shuttling which is the displaced figuration of the 'third-world woman' caught between tradition and modernization." See Spivak, "Can the Subaltern Speak?" in *Marxism and the Interpretation of Culture* (Urbana: University of Illinois Press, 1988), 271–313.

⁴¹ Gerard O'Neill in Brand, *Space Colonies* (note 16), II.

⁴² "And of course, once you ask the right question, the right answer follows almost automatically. That's simply a question of working out the numbers"; Gerard O'Neill in conversation with Stewart Brand, "Is the surface of a planet the right place for an expanding technological civilization?" in Brand, *Space Colonies* (note 16), 22.

⁴³ Stewart Brand, in Brand, *Space Colonies* (note 16), 6.

⁴⁴ See Fred Turner, "Networking in the New Economy," in Turner, *Counterculture* (note 24), 175–206.

⁴⁵ See Amy Frearson, "BIG and Heatherwick Unveil 'Vibrant New Neighborhood' for Google's California HQ," *Dezeen*, February 2015, <https://www.dezeen.com/2015/02/27/big-and-heatherwick-unveil-vibrant-new-neighbourhood-for-googles-california-hq/> (accessed February 18, 2017).

⁴⁶ Amy Frearson, "Apple 2 Campus by Foster + Partners," *Dezeen*, August 2011, <https://www.dezeen.com/2011/08/15/apple-campus-2-by-foster-partners/> (accessed February 18, 2017).

⁴⁷ Sidewalk Labs, "Platform," at <https://www.sidewalklabs.com> (accessed February 18, 2017).

⁴⁸ Adora Cheung, *New Cities*, <https://blog.ycombinator.com/new-cities/> (accessed February 18, 2017).

⁴⁹ Ibid.

⁵⁰ Judith Butler in Taylor, *Examined Life* (note 26).

⁵¹ Cheung, *New Cities* (note 48).

⁵² Chakrabarty in conversation with Graham, in Graham, *Climates* (note 5), 30.