Rick Guidice. Painting showing interior view of cylindrical space colony, looking out through windows, ca. 1975. Courtesy NASA Ames Research Center.

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Earthlike

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In May 1975, Ludwig Glaeser, then curator of the Mies van der Rohe Archive at New York's Museum of Modern Art (MoMA), presented a paper entitled "Architectural Studies for a Space Habitat" at the Conference on Space Manufacturing Facilities (Space Colonies) jointly organized by Princeton University, the American Institute of Aeronautics and Astronautics (AIAA), and the National Aeronautics and Space Administration (NASA). Trained as an architect and art historian in Berlin during the 1950s, Glaeser joined MoMA in 1963; he was appointed associate curator in 1964, curator of architecture in 1968, and head of the Mies archive in 1972.[1] Hailing from an institution avowedly committed to architecture's aesthetic dimensions, Glaeser's expertise might appear somewhat out of place at a conference dedicated to advancing the scientific, technical, and commercial aspects of space colonization. Glaeser in fact refused to offer an image of what a future space colony might look like or to make aesthetic arguments, and his presentation was received as unduly pessimistic and out of sync with the heroic space colony visions of Princeton physics professor Gerard K. O'Neill, around which the NASA-funded conference was organized. Yet, in retrospect, Glaeser's architectural studies were simply aligned in other ways with technoscientific paradigms born of military research and the space race, and with the technolibertarian ethos fueling O'Neill's agenda, which, after a fitful start, had gained momentum and media attention through his inaugural Princeton Conference on Space Colonization the previous May and his highly popular September 1974 article in *Physics Today*, "The Colonization of Space."

For O'Neill, the largely undisputed answer to the question of how to design a space colony environment was that its interior should simulate the most attractive or "ideal" parts of Earth, with repeated allusions to the California coast, the island of Bermuda, Italian villages, and the South of France—all familiar vacation spots for privileged Europeans and Americans. Thus implying a particular demographic and marking the limits of the imagination at play, such environments provided the visual template for the glossy landscape renderings produced for NASA by artists Donald Davis and Frank Guidice to promote O'Neill's idea. While my aim here is not to "hunt the source," we might recall that both O'Neill's vision and NASA's commissioned renderings had precedents in the work of scientists, engineers, science-fiction writers, and artists who earlier

dreamed of sending human beings into outer space, whether for flight missions, space stations, or colonization.[2] Similarly wavering between science fiction and technical fact, Wernher von Braun's collaboration with "architect-turned-space artist Chesley Bonestell" decades earlier is a case in point.[3] On account of his late entry into this story, O'Neill's space colony visions emerge as a symptomatic reprise of such earlier endeavors, a return that helps identify the transforming coordinates of the technoscientific, economic, political, and geopolitical apparatus within which he sought a foothold.

Glaeser's strategy of operating within the contemporary media-technical, environmental, and institutional apparatus diverged, also in symptomatic ways, from the mainstay of space colony enthusiasts, as marked most vividly in his refusal to deploy architectural visualizations in his presentation. Yet he did not refuse the basic premise of expanding the frontiers of U.S. territory, whether literally or virtually, through the advancement of scientific and technical knowledge and by instituting new mechanisms of environmental control and connecting these mechanisms to potentials for resource exploitation, ambitions common to O'Neill and NASA. With evident media savvy, O'Neill and his followers mobilized a constellation of contemporary anxieties in the United States to gain support for this initiative: resource scarcity, nuclear devastation, environmental degradation, population growth in the developing world, the rise of the nonaligned movement, and the Organization of Arab Petroleum Exporting Countries' decision to declare an oil embargo in October 1973 in response to U.S. support for Israel during the Yom Kippur War. Along with President Richard Nixon's ensuing announcement of Project Independence in November 1973, with its goal of achieving energy self-sufficiency by the 1980s, these allusions to national security concerns and potential states of emergency appeared repeatedly in space colony discourse, participating in a calculated platform to foster a neoliberal future imaginary under the rhetoric of a Jeffersonian appeal to self-sufficiency and self-government.[4]

Offering panaceas to such pessimistic scenarios, and soon armed with seductive renderings commissioned by NASA, space colonies promised a return (albeit a peculiar one) to more-familiar American narratives: they promised to revive the jubilation and pride fostered by the recently discontinued U.S. Apollo missions in their demonstration of U.S. technical supremacy and pioneering know-how, missions launched following the shock of the Soviet Union's launch of *Sputnik 1* into orbit in October 1957. Additionally, space colonies would help extend the American frontier myth—and hence the country's promise of access to "natural" resources—to outer space.

Channeling the specter of Manifest Destiny, President John F. Kennedy had celebrated space travel to the moon as the "new frontier" in the early 1960s. In the wake of the closing of the Apollo program in 1972 and NASA's manned expeditions to *Skylab* in 1974 (the space station orbited until 1979, when it disintegrated upon entering Earth's atmosphere), O'Neill offered an updated vision of territorial expansion and resource exploitation for the 1970s. The revised vision sought support for scientific and technological research while offering NASA new relevance.[5] With elevated and canny rhetoric, O'Neill spoke of human space colonization as the "high frontier," translating narratives of the Atlantic crossing and subsequent westward migration into a vertical axis. As O'Neill and his colleagues insisted, repeatedly likening its potential to the discovery of the New World or the California Gold Rush, this was a frontier with virtually limitless resources to exploit and arenas to colonize but without the burden of, or the security threat arising from, earlier colonial encounters with native populations.

A new era of U.S.-led colonization in outer space, that is, was the avowed goal, offered not through rockets, manned spaceships, or even orbiting laboratories such as *Skylab*, but in the form of truly gigantic postplanetary manufacturing settlements. These would be inhabited by long-term communities

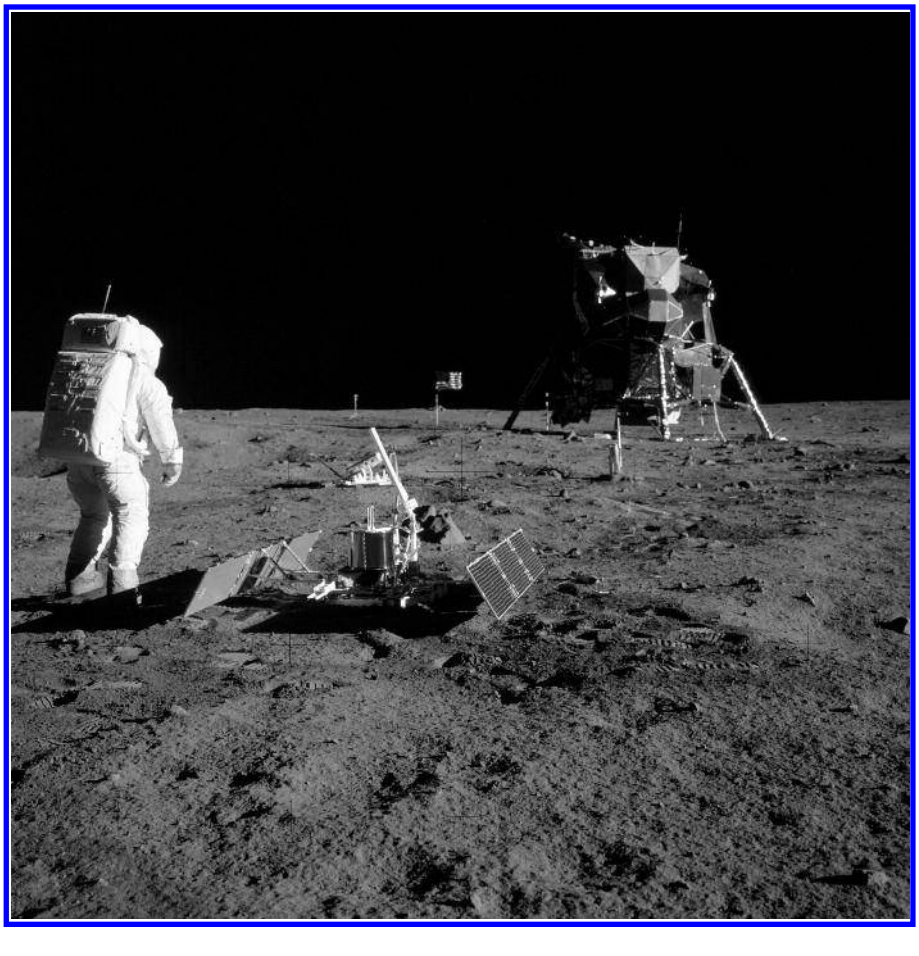
NASA. *Skylab*, July 28, 1973. Courtesy NASA.

that would be more easily regulated and controlled than colonial populations—planners could, after all, decide who was included and who was not—and they were imagined at a scale that made contemporaneous processes of globalization and human migration seem modest. That O'Neill's "high frontier" remained haunted by the legacy of settler colonialism and its violent and inequitable modes of governance was, however, evident as early as the inaugural 1974 Princeton conference. His closing words sought to distance space colonies from histories of colonial genocide and settlers' security concerns: "In contrast to our experience with expanding civilizations on Earth, in space colonization there would be no destruction of indigenous primitive populations; nothing corresponding to the Indian wars of 19th century America."[6] If human colonies in space would be spared such unfortunate complications of settler colonialism, and if they were different in kind from that earlier paradigm (my point here is not to collapse them but to question why the former returns to haunt the latter), this did not necessarily mean that human beings would not suffer adversely, or suffer and benefit asymmetrically from the neocolonial logics of this territorial expansion: given the nexus of national security, economic development, resource exploitation, and colonization at which we find ourselves, we might speculate that, if taking an updated form, the economic benefits of access to near-endless resources or to new territories beyond Earth would not be experienced evenly, whether from the perspective of human beings remaining on Earth or those displaced into outer space.

We can assume that O'Neill sought to avoid repetition in space of colonial violence as it had played out on Earth, his remarks seeking to appease rising Native American nationalism in the United States. But at a historical moment marked not only by indigenous rights struggles in the U.S. but also by recent and ongoing liberation struggles against colonial tutelage, with recently decolonized nations struggling to overcome the legacy of colonial rule while others struggled to address the recent history of Nazi Germany's expansionist ambitions within Europe and that history's postwar legacy of dispossession in Palestine, such invocations of colonial expansion in the service of a heroic narrative read as profoundly ambivalent at best. To this we might add the recent violence of the U.S.-led war in Vietnam and Cambodia; the proliferation of dictatorships ruling U.S. client states in Latin America, Africa, and Asia; and the ongoing environmental exploitation wrought by multinational corporations—to name just part of the litany of the period's expansionist violence. Whether this ambivalence was self-consciously deployed by O'Neill in his appeal to capital or was simply a product of naïveté or overly positive thinking, the expansionist

logic at play implicitly tended toward consolidating extant economic and political hierarchies as powerful players sought to maintain the new world order that had emerged in the wake of World War II.

The story of O'Neill's venture has been detailed in important recent accounts.[7] Here I want to return to Glaeser's presentation at the 1975 Princeton conference. If a small aspect of this much larger story, Glaeser's presentation affords an occasion through which to investigate the commonly imagined, and even perhaps the most evident role to be played by architecture within this enterprise: that of designing spaces for human protection, comfort (physical and psychological), and sociability and hence informing formal appearances and organizational logics that would implicitly or explicitly define new forms of life within the space colonization apparatus. Such a role typically would be performed through the production of images. Glaeser was invited into this context not only as an architect but for the institutional authority and cultural capital of MoMA. O'Neill and his supporters, including NASA, apparently imagined Glaeser would make a visual (or even an aesthetic) contribution, that his presence would supplement the strategic alliance of technoscientific knowledge with economic and political frameworks. If O'Neill's early diagrams and tables



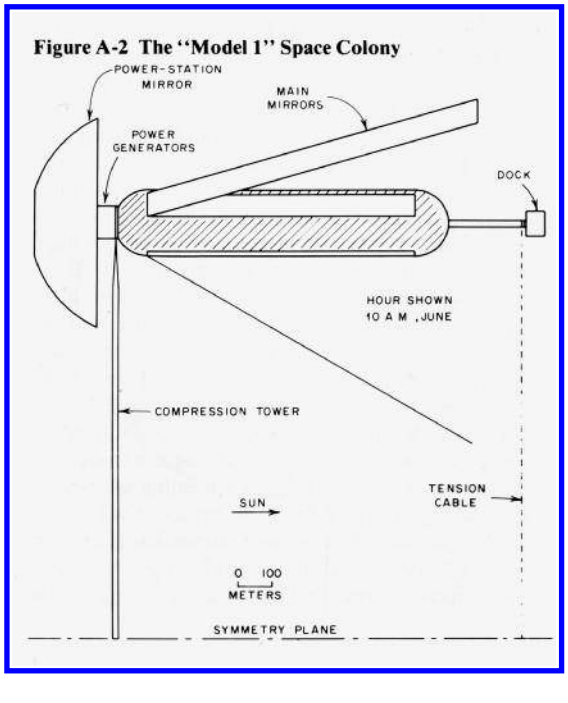
Apollo 11 Moon landing, with lunar module and Buzz Aldrin after deploying solar panels on seismometer, July 20, 1969. Photo: Neil Armstrong. Courtesy NASA.

were schematic at best, NASA understood the strategic use of more seductive visual information, especially following the Apollo program photographs—from Earthrise to spacecraft to the moon landing and beyond—which had so captured the public and political imagination.[8] Glaeser made a different strategic move, however, one that, in retrospect, tied architecture in even more forceful ways to emerging techniques of power and the technoscientific epistemologies and economic strategies attending them.

Coming into a heightened visibility in the mid-1970s, space colonization was always and already situated at an unstable chiasma of scientific, technical, political, and economic paradigms, on the one hand, and visual or media strategies on the other. Glaeser's contribution vividly reminds us that imagining the future was and remains a field of political struggle and a field within which architecture remains relevant. His contribution helps to render visible some of the ways architecture opens out toward or operates within an expanded apparatus of power.

IIIII

The 1975 conference was largely dominated by technical discussions led by scientists and engineers working within universities, corporations (System Development Corporation, Lockheed Missiles and Space Company, Analog Precision, Inc., Boeing, COMSAT), and U.S. scientific and military agencies (NASA's Lunar Science Institute, Johnson and Goddard Space Centers, Ames Research Center, and Jet Propulsion Laboratory, as well as the Naval Aerospace Medical Research Laboratory), along with a small salting of legal, diplomatic, and management experts. Following O'Neill's plan, presentations attended to constructing the first colony, replete with a "self-sustaining ecological system," agricultural and industrial production, natural sunlight, simulation of Earth-normal gravity (by exploiting the Coriolis effect), atmospheric pressure, and day and night cycles, and in permanent orbit within the next few decades. The first colony, to be known as Model 1 or Island One, a base-station of two thousand inhabitants from which further colonies would be launched, was to be located at L5, a Lagrange libration point of stable equilibrium between the Sun, the Earth, and its moon; that is, a point where the colony could retain its position in the celestial orbit without having to accelerate. The colony was

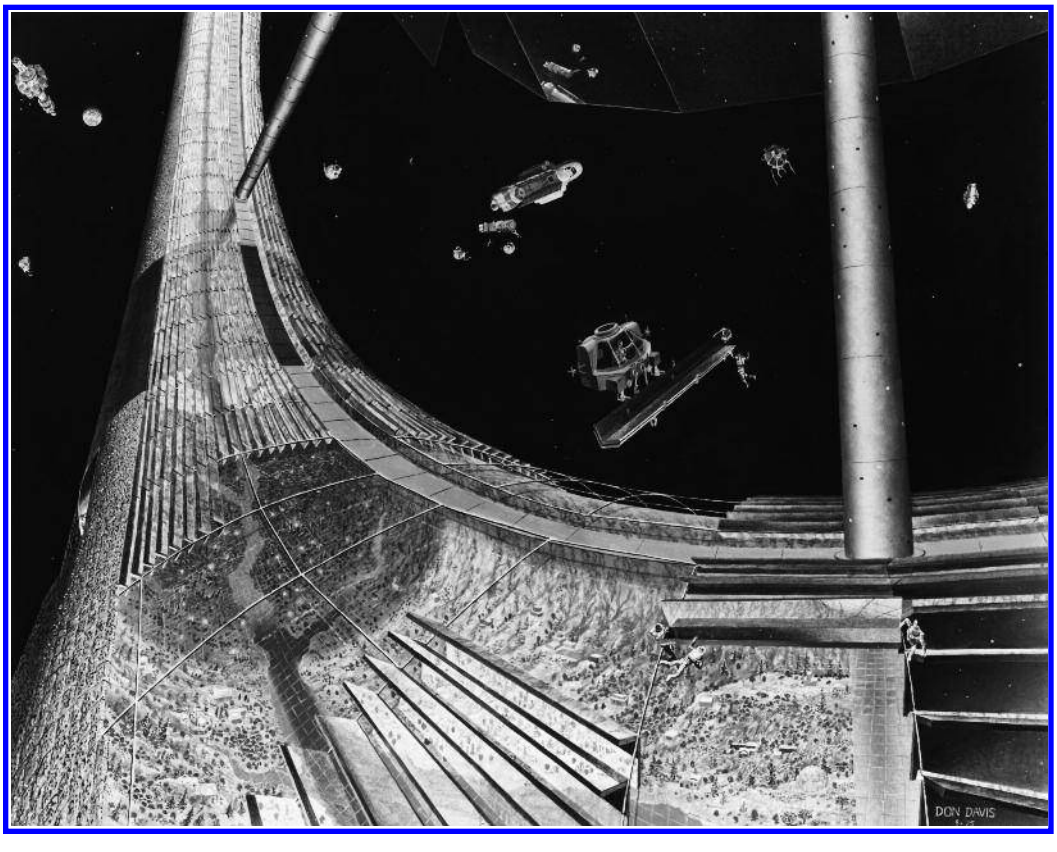


Below: Diagram of Model 1 Space Colony, ca. 1974. From Gerard K. O'Neill's presentation in *Space Manufacturing Facilities* (*Space Colonies*) (1977).

Opposite: Don Davis. Painting showing construction along the torus rim of a space colony, looking onto nearby space vehicles, 1975. Courtesy NASA Ames Research Center.

to take the form of a pair of giant cylinders rotating to simulate gravity, with alternating strips of land areas (valleys) and windows (solars), the shell fabricated from metal cables "bunched to form a coarse mesh in the window areas" and subdivided into smaller glass or plastic infill panels.[9]

Reports revolved around three subject areas: first, how to construct space colonies using extant or "now" technology (examining the viability, excavation, transport, and processing of lunar and asteroid materials as resources for fabrication); second, the productive and profitable activities to take place in them (chemical and industrial operations that benefit from such environmental conditions as zero gravity and vacuums, agricultural production in closed ecosystems, and satellite solar power stations to beam energy back to Earth); and third, the subject area addressed by Glaeser's presentation, "human considerations" (physical and psychological problems born of weightlessness, rotation, and isolation; meteoroid and cosmic ray protection; and social and political organization, governmental and legal frameworks, and communication technologies for life in outer space). Finally, representatives from NASA outlined existing and planned government activities, including space stations, shuttle technologies, lunar colonies, and lunar mining outposts, funding for which had become increasingly threatened in the post-Apollo era. As NASA representative Robert Freitag reported at the conference, the agency was reevaluating its options for space. Following three landmark



events—President Dwight D. Eisenhower's 1955 initiation of the space program; President Kennedy's decision in 1961 to take it from a "research" to an "operational" phase, launching Apollo, the COMSAT Corporation, a massive defense program, and a civil satellite program; and President Nixon's reduction of the budget, focus on applications, and institution of "international cooperation" in 1969—NASA was "conducting its 'Outlook for Space' study, the DOD its 'New Horizons 2.'"[10] O'Neill's claims for space colonies offered prospects for such an ongoing "outlook."

"Before one can reasonably speculate on what the environment of a space habitat might be like," Glaeser began, revealing his indebtedness to systems theory and alluding to a shift from aesthetic concerns to regulatory modalities, "it is essential that the function of that habitat within the total system of the space colony be defined." Forewarning the audience that he would depart from conventional expectations attending an architectural contribution, and distancing his approach from O'Neill and NASA, he continued, "hence this presentation, tempting as it might have been to the architects in our group, is not full of images of the fabulous interiors of space habitats; such an approach would be premature and even misleading."[11] Glaeser was not proposing that architecture take a back seat in the creation of these artificial environments, however. Architecture, he insisted, was not to be regarded simply as a visual or even organizational affair (let alone an aesthetic one) but had to be considered within a "full range of design tasks, from environmental systems to hardware specifications." But one had first to ask, "In what sense is the function of the environment significant to the total colonization effort?"[12] The problem, Glaeser contended, alluding to a dominant trope within O'Neill's discourse, was not simply to simulate Earth-born preferences, ranging from alpine areas to subtropical islands: "What could be more idyllic, or, if you wish, utopian," Glaeser mused, "than the prospect of an existence in pollution-free environments, with weather made to order and landscape on demand? While contemplating such a prospect is attractive, it is far too simplistic a view of the actual challenge."[13]

Glaeser insisted instead on the strategic importance of capturing and regulating the colonial subjects' imagination and productivity in a more everyday and totalizing fashion than representational strategies might be able to do. That is, a space colony had to figure nothing less than a new form of life. "This environment must not only be capable of attracting colonists to live in space," he proposed, referring to O'Neill's limited rationale, "but also must be able to sustain their non-heroic day-to-day existence for years at a time."[14] Addressing the physical and psychological stresses of outer-space missions, NASA had

earlier commissioned extensive research dedicated to sustaining human life in outer space—environmental, physiological, perceptual, and behavioral. Glaeser homed in on selected issues, arguing that the environment should be capable first of replicating variety within a limited, internalized space. The highly educated people Glaeser envisioned to be the colony's first, carefully selected inhabitants might be averse to "a non-stimulating, regimented existence."[15] A second major challenge, in Glaeser's estimation, was the "unprecedented perceptual phenomena" of an inside-out world, including the evident curvature, peculiar topology, and scale distortions of an enclosed space, along with the reflected lighting, mechanical control of day and night, and artificial atmospheric pressure and climate. In his view, the architectural environment within this new world, which ranged from shelter and furniture to utensils and clothing—a total design regime long claimed by MoMA's Department of Architecture and Design as its disciplinary domain—had to function not only visually but as a "mediating mechanism" between the outer shell of the space colony (designed by engineers) and the "existential requirements" of its select population.[16] He cast the shell and the population as two sets of "givens" with concomitant restraints that had to be "brought together into one functional system" through architecture and design: it was a hyperfunctionalism conceived for a hyperartificial milieu; an architecture integrating physiological, cognitive, social, technical, and cultural parameters into a single regulatory apparatus that would serve to more effectively govern—*manage* might be a better word—the space colony subjects suspended within it.[17]

Underscoring the centrality of social-scientific knowledge and channeling a then-popular discourse on stress, Glaeser additionally posited that the architectural environment should counter "the development of stress reactions" given the "extreme novelty of the environment, reinforced by the perceived isolation of life in space."[18] Speaking of the main enclosure as "an unadorned, large void," Glaeser noted that such a space colony was "obviously a potential stressful environment by virtue of its initial lack of environmental stimuli." The question for architecture, then, was "how it [the unadorned, large void] should be supplemented in order to alleviate the potential for stress," again both physical and psychological.[19] The answer was not ornament or visual interest in the conventional sense or even at the scale of Earthlike landscapes.

Here we find ourselves at a notable point of tension then playing out in postwar modernism and proximate to Glaeser's work. When Mies designed the Chicago Convention Hall project in 1953 or the Neue Nationalgalerie the following decade, such heroic glass and steel spans were still understood by most

as the apotheosis of a modernist trajectory engaging industrial and engineering structures for utopian ends. But by the late 1960s such works had taken on new valences: many critics now posited that modernist aesthetics appealing to engineering harbored ornamental qualities, despite architects' claims to the contrary; and in corporate and institutional form it became evident that such streams of architectural modernism manifest affinities with the administrative logics informing the U.S.-led global expansion of late capitalism. That more dystopian aspects of modernism were on the mind of architects and known to Glaeser is evident, for instance, in the ironic architectural fantasies of Superstudio and Archizoom on display in MoMA's 1972 blockbuster exhibition curated by Emilio Ambasz, Italy: The New Domestic Landscape.[20]

Glaeser initially was hired at MoMA to undertake research for Arthur Drexler's notorious 1964 exhibition Twentieth Century Engineering, a show avowedly seeking to desublimate the often-sublime aesthetics of vast "unadorned" engineering structures, hence rendering ambiguous assumed disciplinary distinctions between architecture and engineering.[21] From radar, television, telescope, and other communications installations to gigantic power generators and mining facilities, or large-span structures such as domes or transportation infrastructure, the exhibition's message was the same: "the objectivity of engineering is a myth"—all such "rational" structures harbor cultural and aesthetic supplements. Mies's recent work, Drexler wryly posited in this context, "has opened the way for others to restate Ruskin's depressing conclusion: that architecture after all is only the decoration of structure."[22] But architecture, as Drexler well knew, functioned in many other registers than the technical or aesthetic—and regardless of whether these poles were collapsed into each other or cast in opposition. At the time of the space colonies conference, having recently curated a show on the subtly beautiful tensile and membrane structures of the environmentally conscious German architect Frei Otto, Glaeser was researching greenhouses (once celebrated as the ur-form of a postornamental architecture) for an exhibition that did not take place. Aspects of his reading of this nineteenth-century typology and its ability to create artificial climates—he referred to the architecture as "the container of a controlled environment"—appeared in March 1974 as "Greenhouse Architecture: Notes on a Genesis of Form for Roche-Dinkeloo's Recent Work."[23]

"Greenhouse Architecture" rehearses customary modernist narratives, focusing on Joseph Paxton's Crystal Palace of 1851 and its lingering impact upon the imagination of European modernists, now mobilized to explain greenhouse-like spaces in the work of Kevin Roche and John Dinkeloo. With the exception

of the Climatron in St. Louis, inspired by R. Buckminster Fuller and featured in *Twentieth Century Engineering*, it is hard to find depictions of interior environments that come much closer to space colony renderings than images of Roche and Dinkeloo's Ford Foundation Headquarters in New York (1964–1968) and their Fiat Headquarters project in Turin (1972–1976), both of which sought to create isolated, secure, and artificial environments. Here was an architecture not only resonating with a modernist aesthetic but, through an inverted spatial topology and organizational logic, embodying new and expanded techniques of environmental control.[24] Space colonies proposed to take the cultural imaginary and visual coordinates associated with such controlled interior spaces—long tied to global expansion and free-market ideals, from the importation of exotic plants from colonial holdings to the celebration of industrial might and international trade at the Great Exhibition of 1851—to an entirely new scale and into outer space.[25] While interior landscapes were by the 1970s familiar to Americans from corporate atriums and other so-called privately owned public spaces, space colonies offered a schema for similarly suspending populations within ambiguous domains at the scale of

Interior of the Crystal Palace, Sydenham, south London, 1854. Photographed during the move and reconstruction of the 1851 edifice originally in Hyde Park. Photo: Philip Delamotte © Victoria and Albert Museum, London.

entire cities or colonial city-states. Effectively uncoupling people not only from their place of birth but from Earth (and hence from the *terra* in *territory*) and relocating them in a new sort of place, one that rejected terraforming of planets in favor of creating new privatized ground for privatized citizens, space colonies rendered not only environmental and psychological dimensions but also social, political, legal, and even geographic factors all potentially subject to redesign and corporate management.

At the Princeton conference, Glaeser underscored that what drove the proliferation of utopian renderings of space colony environments was the long-standing assumption that "an ideal Earth-like environment, far from being stress provoking, would act as a positive inducement for space colonization."[26] From the earliest days of O'Neill's proselytizing, the promise of Earthlike landscapes in outer space, combined with the high-tech visual rhetoric of the U.S. space program, was central to creating momentum and hence financial support for his research. But the visual mediation of O'Neill's polemic shifted dramatically from technical diagrams to other media only with NASA's help and in the immediate wake of the Princeton conference. When, in July 1975, O'Neill testified about the benefits of space colonization to the U.S. House of Representatives' Committee on Science and Technology, he arrived armed not only with his well-rehearsed verbal pitch but with a space colony model, detailed artistic renderings, and even a short film, *Space Colonization*, produced by NASA in association with the National Public Affairs Center for Television and Dolphin Productions, New York.

Within Glaeser's understood behavior-environment coupling, such attempted visual simulation of Earth's environment in outer space raised "conceptual questions" about what was essential versus extraneous to perception: "Must we simulate it literally, with real spreading oaks where the scenario calls for it, or can we substitute a Styrofoam oak or perhaps a stylized one made of titanium mined on the moon; perhaps a hologram of an oak will do?"[27] Could any such simulation, he queried with an irony evidently lost on many present (who picked up on his oak tree example as a technical problem), really alleviate the sense of estrangement, isolation,

KRJDA. Ford Foundation Headquarters, New York, 1963–1968. Interior view of atrium garden.

and lack of variety or cover over the joints of such an artificial construction? "It may well be," he concluded in a Jamesonian turn of phrase, placing O'Neill's conception on its head, "that the very artificiality of such a simulation approach would be a source of stress in itself—the stress of a schizophrenic existence in which the inhabitant is asked to accept the illusory as the real."[28]

Departing from such a model of environmental design—what he called adjusting "the physical environment to suit the conception and habits of a population raised on Earth"—Glaeser laid out two alternatives. First was to train the space colony population to adapt both physiologically and cognitively to an artificial environment designed specifically for them, using behavioral control techniques such as biofeedback, transcendental meditation, or operant conditioning. If, as he posited somewhat optimistically, a social engineering approach "provid[ed] optimal predictability about the behavior of the inhabitants" and hence potentially the most precise correlation between design and human subject, it "raises the specter of creating a society designed to fit the constraints of life in Model 1, but potentially ill-suited for life in larger models or on Earth." Hence, despite its possible New Age appeal, the limited applicability and deterministic logic of such operant conditioning, Glaeser suggested, might have "a negative influence on the recruiting of future satellite populations."[29] Glaeser was not refusing social engineering or behaviorist approaches, strictly speaking: in a second departure from simulation models he suggested another, less self-evident and hence seemingly more palatable but similarly pernicious version of them, one increasing the lack of distinction between illusion and reality. Indicating the direction of his future research, he proposed that the architectural environment be conceived instead as an "open-ended opportunity system, one capable of facilitating the greatest number of activities in space with the greatest amount of flexibility in time." Here, he posited, lay the "closest possible fit between the habitat and its population," both parties within his flexible mediating mechanism now understood as subject to continual change.[30]

Explicating the epistemological and operational shift he was proposing, Glaeser appealed to formulations familiar from recent experimental architecture. "To be precise, the role of the environment in this respect is not deterministic but only facilitating," he proposed, "inasmuch as the presence of certain kinds of spaces may invite the occurrence of certain kinds of activities," and vice versa, since particular configurations of areas such as informal public space, he believed, might also stifle unwanted behavior. The architectural environment of the colony, that is, would be orchestrated not just to facilitate

the production of goods in space and to shelter the population but to be a nondeterministic but nevertheless directed apparatus to sponsor new forms of subjectivity and social interaction. Refusing modernist desires to "plan a single environment which anticipates and details all possible needs," Glaeser proposed that the architecture be open to spatial alterations over time, the whole system regulated not like a disciplinary institution but, in effect, like a post-Fordist system of production. "Mechanical details must be designed to accept flexibility needed in relocating facilities . . . social governances must be developed to direct and control the alteration of the environment."[31]

In this dream of open-ended, flexible, and transformable structures, we find ourselves again in familiar architectural territory. Glaeser's "open-ended opportunity approach" heralded from earlier engagements with cybernetics and systems theory, such as Oskar Hansen's Open Form; Yona Friedman's Mobile Architecture; Cedric Price's architecture of enabling; Candilis Josic Woods's stem, web, and "mat" buildings; Arata Isozaki's invisible cities and *Electric Labyrinth*; and the evolving modular dreams of Japanese metabolists, among many others. Glaeser's "mediating mechanism" was not a refusal of modernism or functionalist determinism as such but, like many such appeals to open-ended formal and organizational strategies, was a means of their updating that might help architecture to account for new complexities. He, too, stressed the need for modularity and standardization, both key tenets of modernism. Industrially produced components had to fit within the larger structural system of the colony and be fabricated efficiently within its domain. Glaeser also insisted, as others would before and after, that, when deployed in a flexible matrix, standardization did not lead to monotony but served merely as the infrastructure of variety, implicitly underscoring the aesthetic character of such flexible structures.[32]

By the mid-1970s, however, such dreams of flexible and transformable architecture had come to be regarded as either impossible to put into effect—even Candilis Josic Woods's Free University in Berlin (1967–1973), a much celebrated built example, was never reconfigured as the architects imagined it would be—or as largely the domain of corporate- or government-funded exhibitions and pavilions, such as Expo 67 in Montreal or Expo '70 in Osaka. Richard Rogers and Renzo Piano's Centre Georges Pompidou, designed in 1971 and completed in 1977, would likewise give the lie to utopias of flexibility and indeterminate programs. As Alan Colquhoun notes, "the introduction of an intermediary group of 'programmers' between the architect and the user makes it an open question whether a 'flexible space' is any more flexible in reality than spaces of a more conventional type." "We therefore arrive at the appar-

ently paradoxical situation," he concludes, "where as a result of making a building more 'democratic' and more sensitive to 'feedback,' we impose on it an even greater inflexibility and turn it into a *Gesamtkunstwerk* of bureaucracy."[33] In his retroactive dismissal of the megastructure movement, *Megastructure: Urban Futures of the Recent Past*, Reyner Banham also reads these visions and their occasional realizations not as bastions of liberal ideals and flexibility but as a continuation of modernist dreams of totalizing environmental control, now affiliated with the vast scale of multinational capital.[34] Just as the tide was turning against such a vision on Earth, a new generation of "dreamers" revisited such rationales for a possible second act in space, recognizing precisely these qualities and seeking similar scales of capital. The architecture presented in NASA's 1975 film *Space Colonization*, developed during the 1975 NASA/Ames–Stanford University Summer Study on Space Colonization, adopted the aesthetic of modular diversity familiar from Moshe Safdie's Habitat from Expo 67 (an avowed reference), its components now distributed horizontally rather than stacked. As detailed by T.A. Heppenheimer under the title "Ventura Highway Revisited," this hybrid scheme was developed by Pat Hill, an architect from San Luis Obispo, taking additional cues from community design from the eastern San Fernando Valley.[35] The artificial territories of space colonies offered the hope that one could still design communities, but those now even less subject to democratic checks and balances than their counterparts in California, which remained bound by earthly laws.[36]

In conceiving of space colony architecture as a "mediating mechanism adjusting the needs of the population to the characteristics of the shell," Glaeser imagined a benevolent apparatus

NASA. *Space Colonization*, 1975. Still from video.

operating as an open-ended system to alleviate physiological, cognitive, psychological, and social stress among colonists and to facilitate opportunities for production. His avowed goal was "to maintain the health and vitality of the space colonists" as they were put to work in an enterprising scheme to harness almost limitless resources while expanding territory for future human settlement. Glaeser was correct that architecture, as a discipline and a profession, always and already serves as a "mediating mechanism." Architecture remains, among other things, an environmental and biopolitical technology that functions to help integrate subjects into sociospatial and administrative apparatuses aligned (at least typically) with dominant systems of power. To certain ears—even to certain architects, whose expertise was being called upon to serve the needs of this rising technocracy, with its increasingly data-driven forms of knowledge and its futuristic political imaginary—expanding the territories of a future capitalist machinery to an extraterrestrial sphere and integrating only productive subjects into this biopolitical apparatus might well have sounded attractive. Here we find ourselves faced with a peculiar solution (or at least a proposed solution, for its likelihood of realization at this point was largely illusory) to problems born of a globalizing world that would bracket out dissenting sectors of the population and be profitable as well, prompting us to ask, "utopian for whom?"

The repeated return of specters from the violent history of colonialism and expansion within the discourse on space colonies, with its unapologetic rhetoric of claiming new territories for human settlement, seems not incidental. It speaks to the risk that an unchecked technocracy might step in to replace political claims of both states and citizens, even claiming to provide answers to long-standing geopolitical conflicts. Glaeser too was aware of lingering affiliations with the history of colonialism and blithely noted, "Further insights may be gained from historical analogies with other colonizing efforts."[37] During the question-and-answer period he was accused of being too pessimistic in questioning the efficacy of renderings of Earthlike environments and people's desire to participate in the colonizing and settlement process. After being assured that vast numbers of heroic pioneers "would just love to go," he invoked an American example affiliated with the westward migration under the ethos of Manifest Destiny: "I'm sure that the number of adventurous people is as unlimited today as it has been in past periods of history; there is certainly a substitute in space for gold in California."[38] In this he might well have been correct, reminding us again that this adventure was intimately connected to resource extraction and financial gain.

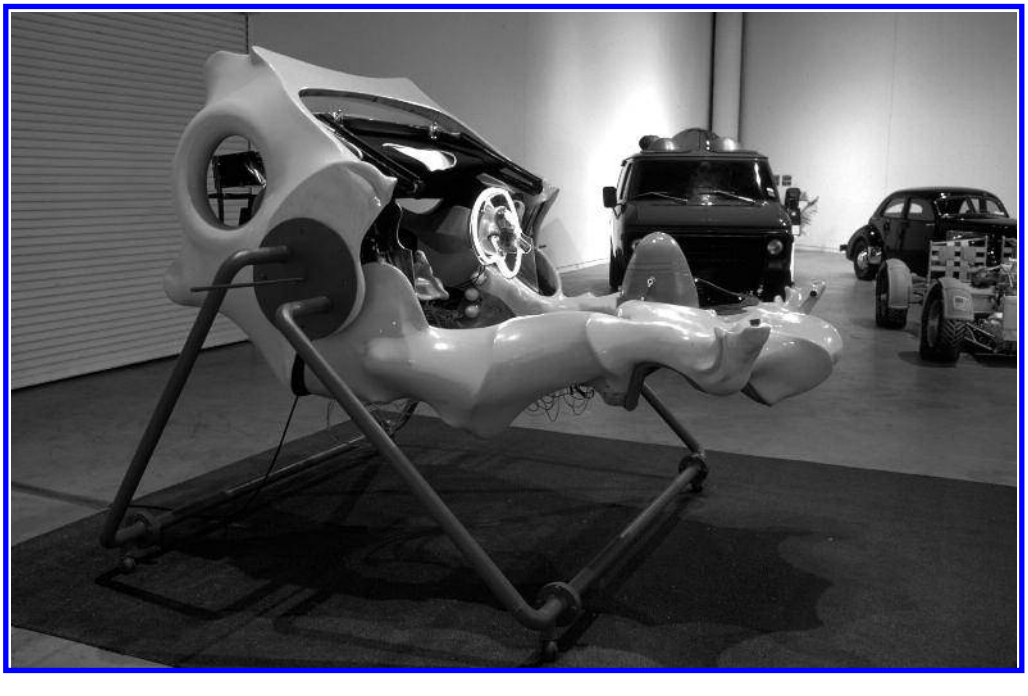
In retrospect, Glaeser's arguments not surprisingly have affinities with central tenets of modernism and postwar experimental architecture engaging cybernetics and computerization, both key to MoMA's exhibition history and both associated in their moment with utopian and progressive ideals and seeking to render architecture relevant to a rapidly transforming world. While many modern architects appealed to vanguard sciences and technologies in seeking legitimation and a professional foothold within dominant governing structures, some experimental architectural practices sought to engage technoscientific paradigms and architecture's social function to less normative ends, and did so through drawings and new forms of architectural visualization. By way of example, I turn briefly to the Ant Farm collective, self-identified architects of the counterculture who entered the game of space colonization through the domain of the image. Attuned to the workings of the military-industrial complex and its media agents, they worked to otherwise engage that apparatus, adopting its know-how, rhetoric, and visual and operational logics but seeking to interrupt or redirect their effects or even simply to render visible the political underpinnings through which architecture and the media operate, to render the apparatus more legible, constructed, and hence more easily subject to critique.

In the winter of 1975–1976, half a year after the Princeton conference, Ant Farm was solicited by Steward Brand to comment on O'Neill's space colony idea in *CoEvolution Quarterly*, the magazine Brand founded in 1974 in the wake of the *Whole Earth Catalog*. Ant Farm member Chip Lord responded, likening space colonies to automobile tail fins in their common roots in World War II technocracy—sharing at once media strategies and Americans' "addiction to machines." He argued that Cadillac's genius lay in realizing that "American consumers responded to IMAGES of technology in far greater numbers than they did to technological innovation." Self-styled "image technologists," Ant Farm knew that images and their means of dissemination were anything but neutral: they were political weapons that could have an impact on the future. Images of technology, Lord reiterated, "were a subtle way of selling an attitude that pervaded the war-time years, and has become synonymous with American Know-how." After the war, he explained, General Motors' Futurama at the 1964 New York World's Fair sent an explicitly expansionist message, from which O'Neill seems to have drawn: with increased mobility even exotic environments like jungles could be turned "into a productive contributor to the world's marketplace."[39] Images of the future, Ant Farm made clear, could stake out positions on a battleground and even create potent allegories of technological and economic visions gone awry. Operating in a market of

competing ideas, each hoped to gain traction and shift the political landscape in its favor.

A few years earlier, Ant Farm's 1973 exhibition at the Contemporary Art Museum in Houston, 20:20 VISION, had connected the entertainment value of popular visions of the future to NASA's image-making skills, asking the question, "What about tomorrow?" In this context they presented NASA's Lunar Rover (the actual vehicle) among an evolutionary lineage of automobiles, also including a live video feed from NASA's Manned Spacecraft Center control room for *Skylab IV*, then in orbit. Staging a critique at the intersection of fictions and facts, they offered their own mediating vehicle, a "Doll House of the Future," named after a foreboding 1973 comet: Kohoutek. Equipped with "a post-privacy surveillance gland that is part machine, part living organism that monitors evolutionary process for the good of all mankind," and with motion no longer dependent on fossil fuels, the display alluded to the deterritorialized condition of "life in a data-controlled future."[40] Speaking to the temporal topology of science fiction as it inadvertently refracted the future into the present, Ant Farm proposed, "Like Futurama of 1939, the Doll House of the Future is a fantasy in model form that no matter how accurate its predictions, will betray its origin in the year 1973," a year marked not only by rapid advances in information technology and the space race, but by "gas wars" launched from the Middle East, a huge political boost for nuclear energy technologies, and a rapidly shifting geopolitical landscape. Space colonies betrayed a similar haunting.

For Ant Farm, the prospect for irony lay precisely in this semantic ambivalence wherein an object supposedly rich in "future shock" resonated uncannily with contemporary norms



Installation view of Ant Farm exhibition 20:20 VISION at the Contemporary Art Museum, Houston, 1973. With, from left to right: Ant Farm's Kohoutek (1973), Ant Farm Media Van (ca. 1971), 1939 Cord, and NASA Lunar Rover (1971). Courtesy Chip Lord.

and pressures—hence the tendency of futurological projections, such as O'Neill's, to provoke uneasy laughter today. If for O'Neill the seductive Earthlike images of colonies in outer space were means through which to convince a sector of Earth's population to participate in his program, hence attracting finance, and if for Glaeser such simulation models were to be deferred or even dismissed as shortsighted and likely to fall into kitsch, for Ant Farm the semifictional and ambivalent character of such futures—and the forms of life they promised—offered the prospect of opening a space for contestatory artistic intervention. Refunctioning familiar images of the future, Ant Farm desublimated the intimate relation of the visual and the biopolitical to shift the valence of technocratic fantasies, situating them not simply as utopian potentials but as strategic fictions with a powerful traction on the real. Glaeser's proposal harbored no such ironic intent. For him, images themselves were sublimated, just as form was left indeterminate, in favor of attempting an even more powerful, if elusive, degree of subjective control.

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In his 1971 futurological speculation, *Architecture 2000: Predictions and Methods*, British critic Charles Jencks positioned "space colonial" at the end of a trajectory he deemed "the logical tradition," referencing similar coordinates to those I have traced. Situating the origin of the logical tradition at the nexus of modernist functionalism and engineering, as exemplified in the work of Robert Le Ricolais, Konrad Wachsmann, R. Buckminster Fuller, and Ludwig Hilberseimer, Jencks traced that tradition as continuing through the space-frame and suspension structures of Jean Prouve, Yona Friedman, Eckhard Schulze-Fielitz, and Frei Otto; in turn, to the parametric work of Christopher Alexander and Shadrach Woods as it was informed by cybernetics and systems theory; and on to "megaform," exemplified both in architectural megastructures and large-scale infrastructure from bridges to covered cities. (The latter had appeared prominently in *Twentieth Century Engineering* during the previous decade.) Illustrated by stills from *2001: A Space Odyssey* and Lockheed Missiles and Space Company's *Space City 1990*, Jencks's space-colonial entry appeared as something of a promissory note at the end of this lineage (it quietly disappeared when he updated the book in 2000, replaced by high tech and eco tech).[41] In its persistent identification with science and engineering, work in this trajectory could, for Jencks, be characterized as so "systematic" and rigorous as to gain "a certain moral authority not found in the other traditions and a contempt for anything which appears as fashion." Exemplars of the "age of science," these scientists and engineers,

he posited, "having access to systematic knowledge are often regarded with awe and assumed to have a monopoly on moral authority, if not truth itself."[42] Here lay a powerful motivation for modern architects' identification with science and technology.

Jencks posited that the complex environmental challenges faced in designing space colonies were well suited to systems-based models that proceeded by breaking down a complex problem into its smallest informatic parameters—elements he saw as "cleansed of their semantic weighting or cultural overtones, so that the designer is as free as possible from preconceptual bias." Hence, he proclaimed, "this field has produced the epitome of parametric design."[43] Beyond using illustrations, Jencks did not speak to specific space colony designs, but given the timing he was most likely referencing those semantically powerful images appearing, initially, in *Architectural Design*'s special issue of February 1967, "2000+," edited by futurologist John McHale and expanded in his 1969 book, *The Future of the Future*.[44] Appearing years before O'Neill's proposals, and presented with an equal lack of irony but evident visual savvy as the vanguard of technological advancements in environmental control, these derived largely from science fiction, NASA, and corporations such as Lockheed Missiles and Space Company, General Dynamics Corporation, and Douglas Missile and Space Systems Division.

Jencks insightfully read space colony designs to operate at a nexus of pragmatic necessity and cosmological or utopian thinking. If he situated the pragmatic aspect as a response to complexity and risk—as manifest in self-discipline, parametrics, and a "cool, ascetic quality"—he traced the cosmological-utopian pole to a fantasy of modernity born in the eighteenth century and exemplified in utopian projects of the French revolutionary architects (Étienne-Louis Boullée, Claude-Nicolas Ledoux, etc.) that shared a cool, ascetic quality and had informed modernist architectural ideals. At this chiasma of pragmatics and utopianism one can identify not only modernist aesthetic traits but, Jencks implied, bringing together his two poles, a shared imperative to total control. From the pragmatic side one engaged science and technology to avoid the imminent threat of a fatal mistake imperiling life itself. And this mapped neatly onto cosmological or ideological narratives to give rise to what he termed "the psychic forces of colonizing space." "All the space cities of the artists and actual designers appear as the oldest Utopian dreams of man: the well ordered city with all systems working exactly on command according to reason and precise calculation."[45]

As with O'Neill and Glaeser, we find that for Jencks, too, albeit to different ends, conceptions of a human future in space remained haunted by the history of colonization, even mani-

festing a lingering colonial dream and reviving narratives of the New World for its neocolonial future counterpart. Space colonies, Jencks noted of the motivation to seek total environmental control, "point to the eternal desire to start again in a new environment without the preconditions and entanglements of the past." In this "dream of the Utopian island completely isolated and secure from its mother community," that is, one finds the same spectral entanglement and the same elision of encounters with alterity: the dream that man could "once again explore an untouched, potentially hostile nature where they can set up local islands cut off from previous civilization."[46] At once haunted by European colonialism and seeking an escape from its "entanglements," space colonies offered for Jencks, too, the potential of realizing a Fulleresque dream of advancing technology within an area beyond the domain of the law—what Fuller and Brand celebrated as an "outlaw area"—and without political contestation.[47] Such technocratic visions remind us that the underlying scientific and technical knowledge remained far from neutral: largely derived from an expanding military-industrial apparatus and seeking further footholds in the free market, space colonization was indelibly marked, if not determined, by such historical and political forces.

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From O'Neill's opportunistic use of images to Glaeser's refusal or Ant Farm's redeployment of them, to Jencks's bridging of scientific authority and utopian aesthetics, we find space colonies situated at an all-too-familiar and ambivalent nexus of conservative ideals and (once) progressive or even avant-garde rhetoric—a terrain wherein they emerge as both interesting and highly problematic historical symptoms, depending on the ends to which they are deployed. Did space colonies offer dreams of working together to create a new land? Were they the last bastion of a modernist or Enlightenment ideology as it might shape the built environment or were they even the most advanced form of a flexible and systems-based architectural milieu? Were they simply specters of the fear that the American way of life might not be sustainable in the future, offering places wherein one did not have to curb energy expenditure, deal with claims to racial and environmental justice and other forms of dissent, or encounter those with other conceptions and forms of life? Were they exceptional zones wherein one could maintain autonomy and avoid conflict, substitutes for the once-safe zones under threat on planet Earth? Or were they futurological fantasies haunted by forces of globalization as nation-states increasingly ceded control to the private sector and the vicissitudes of finance? All such positions played out

in these stories. Mobilizing the catalytic effect of the period's environmental, social, political, and geopolitical anxieties, and armed with NASA's renderings of seductive futuristic visions, O'Neill translated the promise of space colonization into a platform for a neoliberal imaginary of freedom and a secure future for the American way of life, going back and forth between nationalistic claims to U.S. supremacy and, not unrelated, to potentially vast economic gains for corporate partners. In so doing, he effectively captured the imagination of a wide spectrum of cultural, scientific, financial, and governmental players.

This was not accidental: when pitching his vision for space colonies, O'Neill appealed to the U.S. national good, to national security, and to bettering international relations by providing cheap energy as aid to developing nations. He also increasingly identified the private sector as the driving economic force. During his July 1975 testimony to Congress, O'Neill marshaled the language of private interest as it might come to replace government initiatives.

> We have a product for which there is a big market, and which satisfies a need. Where there is a big market there is reason and justification for big investment. We're talking about something which is more like the kind of decision a large manufacturing company has to make when it decides whether to invest in a new plant, than like the traditional idea of our space program: a research-oriented effort from which you never expected to have a direct-dollar return.[48]

Even if no Indians would have to be shot, to recall O'Neill's blithe remark at the Princeton conference, the brave new world of space colonies and their almost endless potential for resource extraction implicitly came with its own form of violent reshuffling, not only in the interest of the state but, necessarily, in the interest of corporate profit, tying an image economy ambiguously to a financial one.[49]

In *Astrofuturism: Science, Race, and Visions of Utopia in Space*, De Witt Douglas Kilgore reads O'Neill's ultimate disavowal of space colonies' utopian dimension and his deemphasizing of political goals "in favor of promises of immense shareholder profits" not only as fueled by racism and the desire for segregation but as the product of his pursuit of finance capital.[50] If cast as a realpolitik or liberal approach, such funding strategies neatly aligned with libertarian and neoliberal ideologies and were also far from neutral; indeed, they did not leave O'Neill's vision untouched. In this sense the seductive images of agrarian and isolated suburban futures accompanying O'Neill's concept functioned in accord with the continually shifting landscape of finance in the 1970s following the U.S.

exit from the Bretton-Woods system. If space exploration had always involved a complex association of state and corporate interests, emphasis shifted increasingly to the latter as NASA's mandate was reoriented from directing its research toward space back toward Earth.

Anthropologist David Valentine traces the entrepreneurial afterlife of 1970s space colonization fantasies to today's commercial NewSpace industries. Seeking to harness finance capital, NewSpacers emerge in his analysis as grand visionaries, as "powerful social actors," and even as a new social movement tragically caught up in the short-term temporality of the market for investment. Although recognizing that NewSpace can be read as an extension of neoliberalism in its most libertarian form into outer space, and acknowledging its commitment to American exceptionalism, Valentine nevertheless wants to recover the NewSpacers' ambitions as harboring more than pure self-interest. He positions them as bearers of a cosmological vision for the survival of the human race (as a species) and the evolution of new forms of human sociality, as retaining a utopian conception of the future no longer available, or so they claim, through government planning. But the question, ultimately, is not simply whether one can identify a lingering humanist or utopian agenda but in whose interest such a vision and its marketing tools ultimately operate and against whom, knowingly or otherwise, it works. Indeed, in retrospect, space colonization enthusiasts' untrammeled pursuit of finance capital and O'Neill's willingness to align social and political "visions" with the mandates of commercial ventures read almost like an allegory of financialization as it radically transformed economic paradigms during the 1970s and persists into the present. As Joseph Vogl argues in *The Specter of Capital*, "'Financialization' processes have tied the reproduction of societies to the reproductive forms of capital. In a kind of large-scale experiment, the attempt has been made to adapt systems of social and political order to situations of economic risk."[51]

What then might we conclude from Glaeser's refusal to offer a visual image of the future too quickly, preferring instead to script a set of systems-based protocols for design of the environment and behavioral control of the population within it? Glaeser's conception of architecture as a mediating mechanism, a technology that integrates subjects into the desired social and economic workings of the space colony—an apparatus seeking to capture their attention and their bodies beyond the visual domain—harbors an insight largely masked by the Earthlike environments promised, at least initially, by O'Neill and given a visual character through artists commissioned by NASA. For if Glaeser's mediating mechanisms were presented under the rhetoric of choice, diversity, flexibility, and change—

and as a liberating departure from a disciplining modernism—his cybernetics- and systems-based approach, coupled with behaviorist techniques, promised nothing less than a more effective control mechanism, one whose components could be studied and recalibrated with ease to suit the shifting vicissitudes of the system and its regulatory and financial protocols.

While visual images retained a distinctive power to mobilize support and even funding, facilitating the advancement of "utopian" visions of the future, Glaeser recognized, at least implicitly, that power was shifting from the material, economic, and technical know-how embodied in the agriculture and industrial machinery depicted in the NASA renderings, toward new paradigms of social science, information science, cybernetics, and computerized data management. Products of wartime interdisciplinary collaborations that persisted after World War II in what Senator William Fulbright termed the military-industrial-academic complex—the Princeton conference itself being modeled on earlier interdisciplinary think tanks—these were arenas of expertise that exerted a powerful impact upon the architectural imaginary of the late 1960s and early 1970s.[52] Ant Farm, too, recognized this transformation toward an information economy and its distinct image operations, and it could not have been lost on O'Neill. In an apparently strange twist of fate, such engagements with the social and information sciences and data-driven logics would soon become marginalized in architecture, or perhaps simply sublimated, in favor of the return of precisely such a pictorial logic, eclipsed by post-avant-garde visual archaisms celebrated most forcefully by Jencks in his missions at the front line of historicist postmodernism in the late 1970s.[53] We might speculate that it is precisely at moments when images of archaic if often aesthetically pleasing architectures or reassuringly beautiful Earthlike environments seem most out of sync with the regulatory ambitions of technoscientific logics and economic regimes, when aesthetic and formal attributes seem to wane in importance compared to the working of biopolitical systems or apparatuses, that such images return, symptomatically, as hyperbolic representations. That is, the resurgence of traditional, conventional, or familiar images and aesthetic paradigms or even media logics functions sometimes less as a panacea to the advancement of technocratic or neoliberal regimes than as a glaring if not-quite-transparent symptom of them. Faced with such ambiguous or unstable aesthetic and visual logics, Glaeser's strategy thus appears not as a refusal of the biopolitical logics of space colonies, but (in a modernist bent) as a refusal of such aesthetic supplements while simultaneously attempting to render that apparatus legible.

Images and rhetoric tell only part of any story. Moreover,

they are effective if unstable vehicles not only for supposedly transparent forms of communication but also for often intentionally less-transparent forms of dissimulation or distraction. Revealing his earlier claims to be something of a ruse, in January 1976, during a presentation to the U.S. Senate Subcommittee on Aerospace Technology and National Needs, O'Neill backed away from the idea that space colonies would *appear* like the most beautiful places on Earth. Although still situating his vision at the nexus of private industry and colonization, he invoked another American trajectory, noting that the first facilities would "be much more like a Texas-tower oil rig, or a construction camp on the Alaska pipeline, or like Virginia City, Nevada, in about the year 1875."[54] In this iteration, too, however, space colonies remained distinctly Earthlike, as did the matrix of power within which they operated. The question at stake for architecture is thus not merely to understand the scientific and technical parameters informing such mechanisms of environmental control, as well as their visual and aesthetic logics, all of which remain important. As with the history of architecture on Earth, at stake is not simply what the architecture of a space colony might look like—cool, ascetic, or futuristic in form, flexible apparatuses functioning equally well across the political spectrum—but how we might read the ethical and political agendas motivating architecture to enter this ambiguous battlefield and how we can understand the means and the ends the discipline serves.

Notes

I thank, first, Eric de Bruyn not only for shepherding this into print but for the invitation to expand my work on space colonization, first undertaken in the context of research for *Outlaw Territories: Environments of Insecurity/ Architectures of Counterinsurgency* (and appearing briefly in that work's conclusion). I also thank Lucia Allais and John Harwood for their insightful, helpful, and welcome editorial comments on an earlier version of this text.

1. According to MoMA's press release upon his appointment to the Mies archive, Glaeser trained as an architect at the Technische Universität, Berlin, then studied art history and anthropology at the Freie Universität, where he received a PhD. Having worked in Berlin with architect Eduard Ludwig, Glaeser was instrumental in bringing surviving drawings from Mies's period in Germany to MoMA, which became part of the archive. At MoMA he curated The Architecture of Louis Kahn; The Architecture of Museums; Theo van Doesburg: The Development of an Architecture; and Work of Frei Otto. See Museum of Modern Art Press Release no. 58, May 5, 1972, available online at https://www.moma.org/docs/press_archives/4836/releases/MOMA_1972_0065_58.pdf?2010.

2. Fred Scharmen offers a compelling archaeology of the visual culture informing these renderings, identifying sources from science fiction novels dating back to the 1950s, the research of Wernher von Braun, films such as Stanley Kubrick and Arthur C. Clarke's *2001: A Space Odyssey* of 1968, and the phenomenon of architectural megastructures. Unlike other visions, he notes, O'Neill saw space colonies not as rooms in space but as new ground upon which to erect a new architecture. Fred Scharmen, "The High Frontier, the Megastructure and the Big Dumb Object," paper presented at the 101st ACSA Annual Meeting, San Francisco, 2013.

3. See John Harwood, "*Skylab*, or the Outpost," *AA Files* 61 (2010): 93–99. The characterization of Bonestell is from this source. See also Ron Miller, "A Brief History of Space Art," in *Science Fiction and Space Futures: Past and Present*, ed. Eugene M. Emme (San Diego: Univelt, 1982), 107–20.

4. In a 1976 *Penthouse* interview, for instance, O'Neill insists in distinctly American rhetoric that space colonization is "a natural continuation of greater freedom, a greater amount of diversity and control over the environment." "Penthouse Interview with Dr. Gerard K. O'Neill," *Penthouse* 8 (August 1976): 175.

5. On the end of the Apollo missions and *Skylab*, see Harwood, "*Skylab*, or the Outpost."

6. Gerard K. O'Neill, "A-III: The Colonization of Space," in *Space Manufacturing Facilities (Space Colonies): Proceedings of the Princeton/ AIAA/NASA Conference, May 7–9, 1975*, ed. Jerry Grey (New York: AIAA, 1977), A-11.

7. The most comprehensive accounts of O'Neill and his space colony initiative can found in De Witt Douglas Kilgore, *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia: University of Pennsylvania Press, 2003); and W. Patrick McCray, *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton: Princeton University Press, 2013). For accounts from the period, see Stewart Brand, ed., *Space Colonies* (New York: Penguin Books, 1977). For an important reading of space colonization in relation to Stewart Brand, see Andrew G. Kirk, *Counterculture Green: The Whole Earth Catalog and American Environmentalism* (Lawrence: University Press of Kansas, 2007). A shorter

account also appears in Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006). Both texts relate more closely to other aspects of my space colony research. For other relevant literature, see Peder Anker, "The Ecological Colonization of Space," *Environmental History* 10, no. 2 (April 2005): 239–68; Scharmen, "The High Frontier"; and Fred Scharmen, "Ground into Sky: The Topology of *Interstellar*," *The Avery Review*, no. 6 (March 2015), http://www.averyreview.com/issues/6/ground-into-sky. See also Felicity D. Scott, "Securing Adjustable Climate," in *Climates: Architecture and the Planetary Imaginary*, ed. James Graham et al. (New York: Columbia Books on Architecture and the City; Zurich: Lars Müller Publishers, 2016), 90–105.

8. On the release of NASA's images, see Denis Cosgrove, "Contested Global Visions: *One-World*, *Whole-Earth*, and the Apollo Space Photographs," *Annals of the Association of American Geographers* 84, no. 2 (June 1994): 270–94; Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010); Laura Kurgan, *Close Up at a Distance: Mapping, Technology and Politics* (New York: Zone Books, 2013); and Felicity D. Scott, *Outlaw Territories: Environments of Insecurity/Architectures of Counterinsurgency* (New York: Zone Books, 2016).

9. Gerard K. O'Neill, "The Colonization of Space," *Physics Today*, September 1974, 33.

10. Robert F. Freitag, "Summary of Problems of Greatest Urgency," in *Space Manufacturing Facilities (Space Colonies)*, 206.

11. Ludwig Glaeser, "Architectural Studies for a Space Habitat," in *Space Manufacturing Facilities (Space Colonies)*, 175.

12. Glaeser, "Architectural Studies," 175.

13. Glaeser, "Architectural Studies," 175.

14. Glaeser, "Architectural Studies," 175.

15. Glaeser, "Architectural Studies," 176.

16. On challenges to MoMA's original formulation of architecture and design, see Felicity D. Scott, *Architecture or Techno-utopia: Politics after Modernism* (Cambridge, MA: MIT Press, 2007); and Felicity D. Scott, "Underneath Aesthetics and Utility: The Untransposable Fetish of Bernard Rudofsky," *Assemblage* 38 (April 1999): 58–89. See also Mark Wigley, "Whatever Happened to Total Design?" *Harvard Design Magazine*, Summer 1998, 18–24.

17. Glaeser, "Architectural Studies," 175.

18. Glaeser, "Architectural Studies," 176.

19. Speaking of the potential for the "development of stress reactions," Glaeser explained, "We understand stress, following [David] Glass and [Jerome] Singer's definition, as 'the effective behavioral and physiological response to adverse stimuli.'" Glaeser, "Architectural Studies," 176. He is referring to Glass and Singer's 1972 study, *Urban Stress: Experiments on Noise and Social Stressors* (New York: Academic Press, 1972). See also Hans Selye's pioneering, best-selling work on stress, including *Stress without Distress* (Toronto: McClelland and Stewart, 1974), which was published around the time of the conference. On the ergonomic side of this equation, see John Harwood, "The Interface: Ergonomics and the Aesthetics of Survival," in *Governing by Design: Architecture, Economy and Politics in the Twentieth Century*, ed. Aggregate (Pittsburgh: Pittsburgh University Press, 2012), 70–92.

20. See Emilio Ambasz, ed., *Italy: The New Domestic Landscape:*

Achievements and Problems of Italian Design (New York: Museum of Modern Art, 1972).

21. On the long-standing tension between architecture and engineering, see Antoine Picon, *French Architects and Engineers in the Age of Enlightenment* (Cambridge, UK: Cambridge University Press, 1992); and Andrew Saint, *Architect and Engineer: A Study in Sibling Rivalry* (New Haven: Yale University Press, 2007).

22. Arthur Drexler, "Introduction," in *Twentieth Century Engineering* (New York: The Museum of Modern Art, 1964), n.p. Drexler was one of the first to speak to the ornamental logic of Mies's use of I beams. See Felicity D. Scott, "An Army of Soldiers or a Meadow: The Seagram Building and the 'Art of Modern Architecture,'" *Journal of the Society of Architectural Historians* 70, no. 3 (September 2011): 330–53.

23. Ludwig Glaeser, "Greenhouse Architecture: Notes on a Genesis of Form for Roche-Dinkeloo's Recent Work," *Architectural Forum* 140, no. 2 (March 1974): 77–84. As pointed out in an editorial comment on my paper, Glaeser's title seems to trope on a text from a decade earlier: Christopher Alexander, *Notes on the Synthesis of Form* (Cambridge, MA: Harvard University Press, 1964).

24. See Felicity D. Scott, "Instruments of Environmental Control," in *Outlaw Territories*.

25. For an architectural coordinate, see Sigfried Giedion's connection of the Crystal Palace to free-market ideals in *Space, Time and Architecture: The Growth of a New Tradition*, 5th ed. (Cambridge, MA: Harvard University Press, 1967). See also Giorgio Agamben, "Marx; or, the Universal Exposition," trans. Ronald L. Martinez, in *Stanzas: Word and Phantasm in Western Culture* (Minneapolis: University of Minnesota Press, 1993), 36–40; and Paul Young, "Mission Impossible: Globalization and the Great Exhibition," in *Britain, the Empire, and the World at the Great Exhibition of 1851*, ed. Jeffrey A. Auerbach and Peter H. Hoffenberg (Aldershot, UK: Ashgate Publishing, 2008), 3–25.

26. Glaeser, "Architectural Studies," 177.

27. Glaeser, "Architectural Studies," 177.

28. Glaeser, "Architectural Studies," 177. After entering the summary comments at the 1975 conference, Glaeser's remarks on simulating oaks were picked up as possible solutions by many authors. See, for instance, T.A. Heppenheimer, *Colonies in Space* (Harrisburg, PA: Stackpole Books, 1977), 135.

29. Glaeser, "Architectural Studies," 177.

30. Glaeser, "Architectural Studies," 177.

31. Glaeser, "Architectural Studies," 178.

32. See, for instance, Konrad Wachsmann, *The Turning Point of Building* (New York: Reinhold, 1961); and Nicholas Negroponte, *The Architecture Machine: Toward a More Human Environment* (Cambridge, MA: MIT Press, 1970).

33. Alan Colquhoun, "Plateau Beauborg," in *Essays in Architectural Criticism: Modern Architecture and Historical Change* (Cambridge, MA: MIT Press, 1981), 110–19.

34. See Reyner Banham, *Megastructure: Urban Futures of the Recent Past* (London: Thames and Hudson, 1976); and my commentary on it in the introduction to *Architecture or Techno-utopia*.

35. See Heppenheimer, 134–47.

36. See Heppenheimer, 142.

37. Glaeser, "Architectural Studies," 178.

38. Glaeser, "Architectural Studies," 178–79.

39. Chip Lord, "Space Colonies Are Tail Fins," Ant Farm commentary in *Space Colonies*, 47.

40. Ant Farm, *20/20 Vision*, exh. cat. (Houston: Contemporary Arts Museum, 1973), n.p. For an extended reading of the exhibition, see Felicity D. Scott, *Living Archive 7: Ant Farm* (Barcelona: ACTAR Editorial, 2008).

41. Charles Jencks, *Architecture 2000 and Beyond: Success in the Art of Prediction* (Chichester: Wiley-Academy, 2000).

42. Charles Jencks, *Architecture 2000: Predictions and Methods* (New York: Praeger Publishers, 1971), 105.

43. Jencks, *Architecture 2000*, 105–6.

44. John McHale, *The Future of the Future* (New York: George Braziller, 1969).

45. Jencks, *Architecture 2000*, 106.

46. Jencks, *Architecture 2000*, 106–7.

47. See Scott, *Outlaw Territories*.

48. *Future Space Programs 1975: Hearings Before the Subcommittee on Space Science and Applications of the Committee on Science and Technology*, 94th Cong. (1975) (testimony of Gerard K. O'Neill), 187. The main body of O'Neill's testimony is reproduced in *Space Colonies*, 12–21, but that version elides the preamble, images, and question-and-answer period.

49. See, for instance, Walter Sullivan, "Proposal for Human Colonies in Space Is Hailed by Scientists as Feasible Now," *New York Times*, May 13, 1974, 1, 23.

50. Kilgore, 176–77. Of the racist underpinnings of this dream, he concludes, "O'Neill's argument for future diversity therefore contains a catastrophic tension between an unmarked whiteness representing technological modernity and a marked blackness (racial/cultural others) representing the atavistic survival of preindustrial culture as tourist trophy or exotic spectacle" (177).

51. Joseph Vogl, *The Specter of Capital* (Stanford, CA: Stanford University Press, 2015), 130. Under the subtitle "Economic Imperialism," Vogl ties such processes to Michel Foucault: "The various neoliberalisms may therefore be understood, as Foucault remarked in his lectures on modern governmentality, as programs for a particular technology of government which, rather than interfering directly with the individual, produces milieus in which older regimes of subjection and discipline have been made obsolete" (99).

52. J. William Fulbright, "The War and Its Effects: The Military-Industrial-Academic Complex," in *Super-State: Readings in the Military-Industrial Complex*, ed. Herbert I. Schiller (Urbana: University of Illinois Press, 1970), 171–78.

53. See Charles Jencks, *The Language of Postmodern Architecture* (New York: Rizzoli, 1977) and its many subsequent updated editions.

54. Gerard K. O'Neill, commentary in *Space Colonies*, 70. An editorial note explains that the text was derived from O'Neill's remarks before the Senate Subcommittee on Aerospace Technology and National Needs on January 19, 1976, and a related keynote address at the annual convention of the AIAA in Washington, DC, on January 30, 1976.