Media Machines and Not-So-Utopian Futures, c. 1957
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In the face of environmental pressures, architects and consultants are increasingly aggressive in their attempts to refine strategies of energy efficiency in building. This appears to be a worthy goal, and one of potentially historic consequence: without changes to our building practices, the effects of climate change could accelerate. Such endeavors—such a focus on the material efficiencies of the constructed environment—also resonate across historical phenomena, and allow for a new perspective on the architectures and ideas of the past.

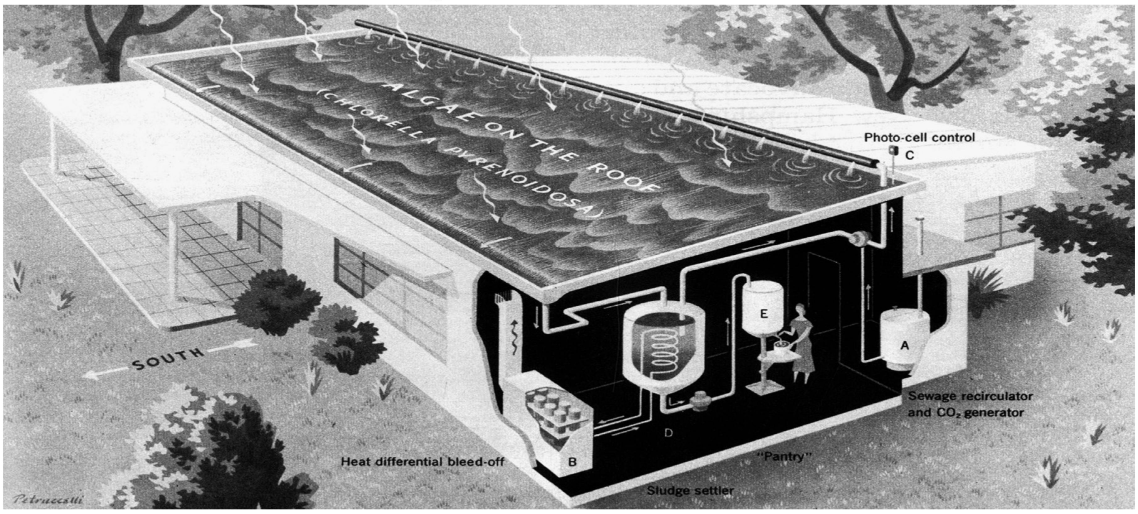
What becomes clear, as a first principle, in examining these histories, is that the imperative for material efficiencies has often been accompanied by specific immaterial effects—cultural interventions that allow for a different relationship between natural and social patterns. Indeed, the cultural changes being solicited by the effects of climate change are much more dramatic, and significantly more of a challenge, than the technological prospects for reducing carbon dependence. This immaterial realm, where decisions about designing or building are examined not only for their reduction of fossil throughput but also for the new cultural patterns and forms of collectivity they imagine, awaits more specific elaboration, and more specific integration into the historical and theoretical discourse of architecture.

The image, broadly considered, is a primary site for this elaboration. Over the past century or so, images produced in an architectural context—diagrams, photographs, charts and graphs, plans, sections, and elevations, and, more recently, renderings—have been a central discursive site for analyzing and absorbing the impact of changes to the natural world. It is in part through this visual discourse that knowledge about the entanglement between human and biotic systems has crossed disciplinary and professional boundaries. Architects produce images, and images contain ideas that speak far beyond the constraints of the disciplines.

Machines produce images, too. In the 1950s, a number of machines were developed in order to more precisely understand the relationship between a building and its climatic conditions. Some of these machines were designed to produce specific material effects in buildings. Contingent historical events, such as the exploitation of oil in the Middle East, compromised the impact of these effects, as buildings were increasingly seen to be able to produce their own climate, isolated from the exterior and generated through the burning of fossil fuels. As a result, many of the devices that had been built to explore methods of making a building more energy-efficient were directed instead towards exploring the complexities of the experience of interior space, and focused on producing images that could imagine new conditions for the human. These are the machines that will be discussed below.

Mark Poster recently offered an important clarification on these terms, articulating a distinction between media machines and mechanical machines. "Media machines," he writes, "act on the components of culture, not nature (if that distinction may still be employed), affecting human beings in a way very different from mechanical machines." [1] Rather than processing materials, media machines process ideas. Poster at once affirms the material/immaterial distinction with which I began, and also indicates, if largely parenthetically and symptomatically, that the images that media machines produce operate precisely on the distinction between human and natural systems, and suggest the evaporating capacity to convincingly deploy that distinction. At stake here is the role that ideas about architecture have played in coming to terms with the entanglement of human and natural systems,

1 Mark Poster, "An Introduction to Vilém Flusser's *Into the Universe of Technical Images* and *Does Writing Have a Future?*," in Vilém Flusser, *Into the Universe of Technical Images*. Trans. Nancy Ann Roth (Minneapolis: University of Minnesota Press, 2011): pp. ix-xxvii; here p. x.



f.1 "A Not So Utopian Future ..." as illustrated in Eric Hodgins's "Power From the Sun."

and the images that have emerged to offer some clarity in this regard. [2] The design of machines that produce images also generates new conceptions across the nexus of the human and the natural world, and opens up access to histories and archives heretofore difficult to see.

To begin with the image of a machine: [f.1] this rendering of "A Not So Utopian Future" accompanied, as a side bar, "Power from the Sun," an article written by the *Fortune* editor Eric Hodgins in 1953 on the potential of solar energy. [3] This image, and many others like it, and indeed many experiments in the architecture of solar energy, are an early indication that, although we tend to think of the American 1950s as a decade of endless economic expansion and consumer growth, of increased

2 Timothy Morton, *The Ecological Thought* (Cambridge, MA: Harvard University Press, 2012); see also Morton, "Architecture without Nature," *tarp: Architecture Manual,* 3 (2012), pp. 20–5.

3 Eric Hodgins, "Power from the Sun," *Fortune*, 48, no. 9 (1953), pp. 130–5, 184–94.

productivity and the unrelenting exploitation of resources—as the great acceleration, in short—voices of caution were raised even then about the relationship between social behaviors and what appeared to be the given condition of resource stocks, and of concern about how the collective behaviors of humans impacted the environment. 4

These anxious voices were focused on gaining increased knowledge about those environmental conditions, and using that knowledge to better intervene in them. The best known of these voices today is that of M. King Hubbert, a research scientist at Shell Oil. In the late 1940s, through careful calculations involving industrial equipment, cost and profit analyses, and geological testing, Hubbert outlined the "[m]athematical relations involved in the complete cycle of production of any exhaustible resource". 5/f.2 Today we call it Hubbert's Peak—or Peak Oil—though he referred to this slim period when fossil fuels were readily available as a "pip" in the historical development of human affairs, "a transient and ephemeral epoch in the longer span of human history;" based on an assumption that fossil fuel sources would soon be replaced by "water power and solar radiation." 6 A related analysis, by a research scientist at Gulf Oil named Eugene Ayres, plays this out a little more carefully. In images he produced for distribution to the oil industry, Ayres attempted to suggest that different levels of research investment into renewables would lead to different possible futures. 7

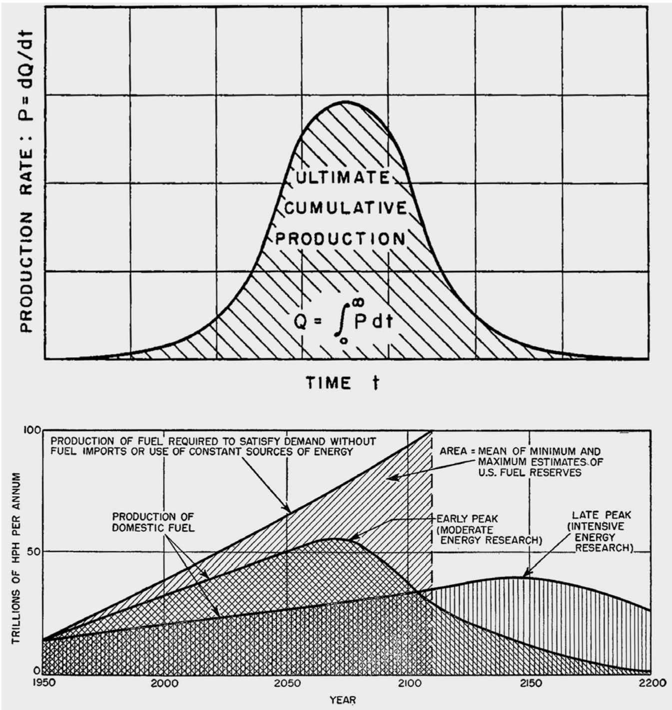


FIG. 5. Some possibilities in our future energy picture.

There were many other expressions of caution, gentle criticisms embedded in drawings, and images of possible futures that offered a check to the promise of progress, however it might have been envisioned. In another image of another imagined machine, the "Faucet Kitchen" drawn by the marketing team at the Schaible Company, a manufacturer of metal filters for kitchen sink drains, a different sort of future is envisioned. f.3 Derisive to the point of absurdity of the many potential improvements technology was seen to bring—the "seeds and chemicals" and the "pre-dehydrated food processor"—the faucet kitchen indicates

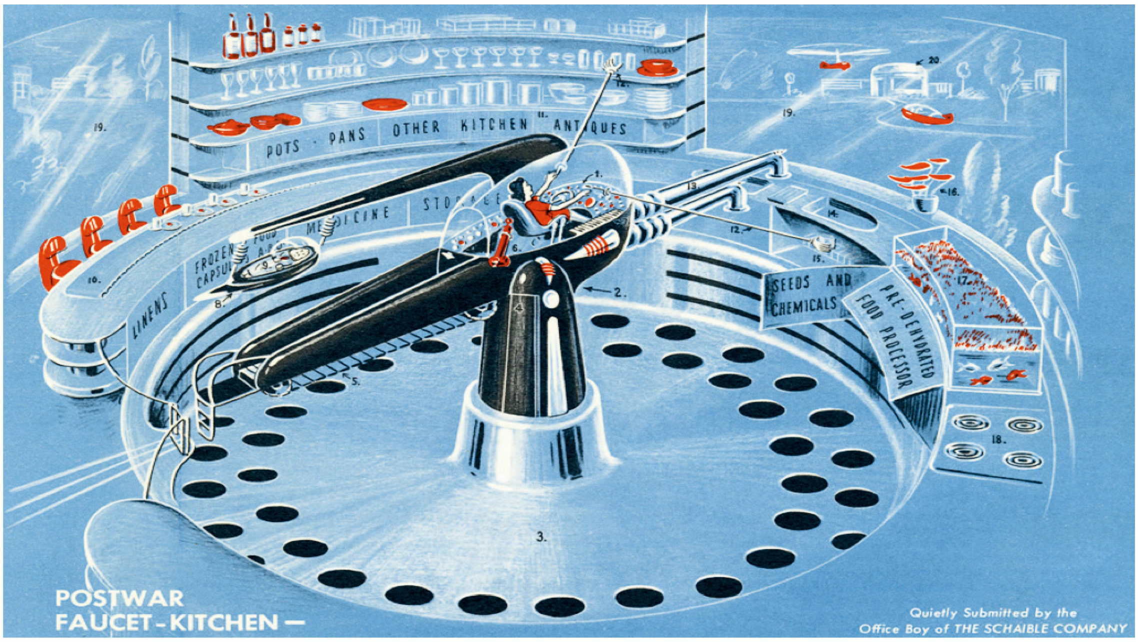
4 Daniel A. Barber, *A House in the Sun: Modern Architecture and Solar Energy in the Cold War* (New York: Oxford University Press, 2016).

f.2 M. King Hubbert, "Mathematical relations involved in the complete cycle of production of any exhaustible resource," from *Nuclear Energy and the Fossil Fuels* (1956), based on a report from 1949; and Eugene Ayres, "Some Possibilities in Our Future Energy Picture," from *Energy Sources: The Wealth of the World*, 1952, based on a 1948 report.

5 M. King Hubbert, *Nuclear Energy and the Fossil Fuels* (Houston: Shell Development Co., 1956), fig. 11, based on a report from 1949, see Hubbert, "Energy from Fossil Fuels," *Science*, 109, no. 2823 (1949), pp. 103–9.

6 M. King Hubbert, "Exponential growth as a transient phenomenon in human history," in Margaret A. Strom (ed.), *Societal Issues, Scientific Viewpoints* (New York: American Institute of Physics, 1987), pp. 75–84; here p. 76.

7 Eugene Ayres, "Major Sources of Energy," in *Addresses and Reports Delivered at the Twenty-Eighth Annual Meeting, Chicago, Illinois, November 8 to 11, 1948* (New York: American Petroleum Institute, 1948), pp. 109–44.



f.3 Schaible Company (manufacturer of sink drains), *Kitchen of Tomorrow*, advertising brochure, 1945.

that technologies were regarded as both productive and disruptive, and as portents of the unforeseen. When Sigfried Giedion published this image in *Mechanization Takes Command*, he noted that "[i]t is a healthy sign that a critique of over-mechanization starts from within industry itself." 8 Here the woman, indeed, is fully in charge, and even liberated from the responsibilities of childcare by the rocking cradle optional attachment. In the suburban landscape out the picture window, whirlybirds and three-wheeled cars dot the landscape, as do other Dymaxion inventions such as the cylindrical house that mirrors the one out of which the viewer is looking. "Pots, pans, and other kitchen antiques" rest in the background—still of some value, apparently, as the mechanical hand is taking a bottle off the shelf.

The not-so-utopian house imaged in *Fortune* plays this out on slightly different terms. "[T]he day is coming," the author wrote, "when population pressures will make wheat fields and cattle ranges luxuries of a dear dead past." This house was the solution, a survival system for a family of four. It had south-facing windows to absorb the heat of the sun in warming the interior; and also used "solar radiation to grow its own food, in the form of algae on its roof." In the "workshop"—a sort of elaboration on the mechanized postwar kitchen—garbage was burned to charge the algal suspension and keep it growing; this algae was filtered, heated, and then could be poured out as "a concentrated sludge … a dark-green paste with a pleasant grassy odor … [and] enough fresh organic matter … to supply the entire protein requirements for the family." 9 "We will come to rely," the article concluded, on "the internal metabolic adjustments by which we shall subsist contentedly … on hydrolysed sawdust and predigested, vitaminized algae." 10 The key word here is

8 Sigfried Giedion, *Mechanization Takes Command: A Contribution to Anonymous History* (New York: Oxford University Press, 1948), p. 580.

9 Eric Hodgins, "Power from the Sun" (see note 3), p. 134.

10 Ibid., p. 194.

"contentedly"—metabolic adjustments and changing conceptions of the psychological and biological makeup of humans will adapt, it was proposed, to a parched earth. Here, the image, imbued with a mixture of irony, paranoia, and caution, suggests the production of a new kind of subject; or, at least, schematizes a relationship between technology, humans, and the environment in which the production of new subjectivity and new physiology accompanies the elaboration of built efficiencies.

Though the house-as-machine imaged in *Fortune* was speculative, if not in fact imaginary, it emerged in relationship to a number of machines, images, and ideas that sought to increase professional knowledge of the potential state of these unknown futures. Innovations in building design and technology, it was supposed, would allow humans to live differently in future conditions, and media machines were essential to producing the future conditions by which human and natural systems would interrelate. Among the most engaging of the machines focused in this period on architecture and the environment was the thermoheliodon. f.4 Designed and built by the Hungarian émigré architects Victor and Aladar Olgyay in 1956 at the Princeton Architectural Laboratory, the thermoheliodon offered a relatively precise picture of the environment in which a building would be placed, so as to render more precise the methods that could inform that building's design.

The device followed on a large number of heliodons designed and built at universities and research centers around the world since the mid-1930s. The heliodon is a relatively simple device: a sunlamp is calibrated along the vertical calendar to provide the seasonal height, and then the building is placed on a platform angled according to latitude. The platform can spin to simulate diurnal patterns relative to the sun's location. [11] In the early 1950s, a group of students at Columbia University calling themselves "The Form and Climate Research Group" used a heliodon there, as well as a simple wind tunnel that they built, to test buildings according to a relatively unsophisticated set of climatic parameters. [12] Other heliodons were built at the University of Kansas, Princeton, and at a number of the tropical building research stations in former British colonies. [13]

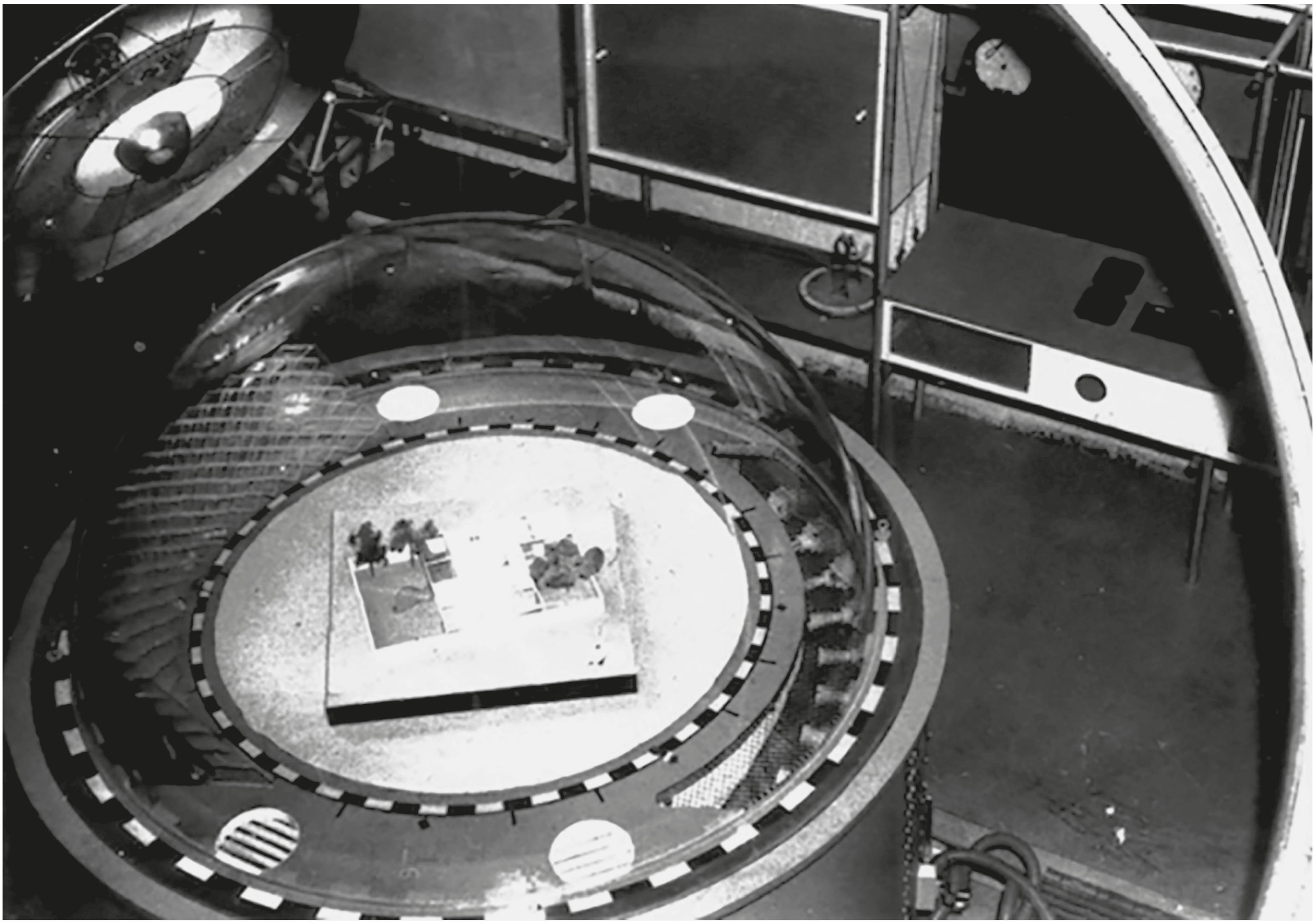
The Olgyays, though not well known today, were recognized in the postwar years for their two books, *Solar Control and Shading Devices* (1957) and *Design with Climate: A Bioclimatic Approach to Architectural Regionalism* (1963), both of which entered into the curricula of architecture schools and sat on the reference shelves of design firms. They built the thermoheliodon to improve on the heliodon by offering a much more precise

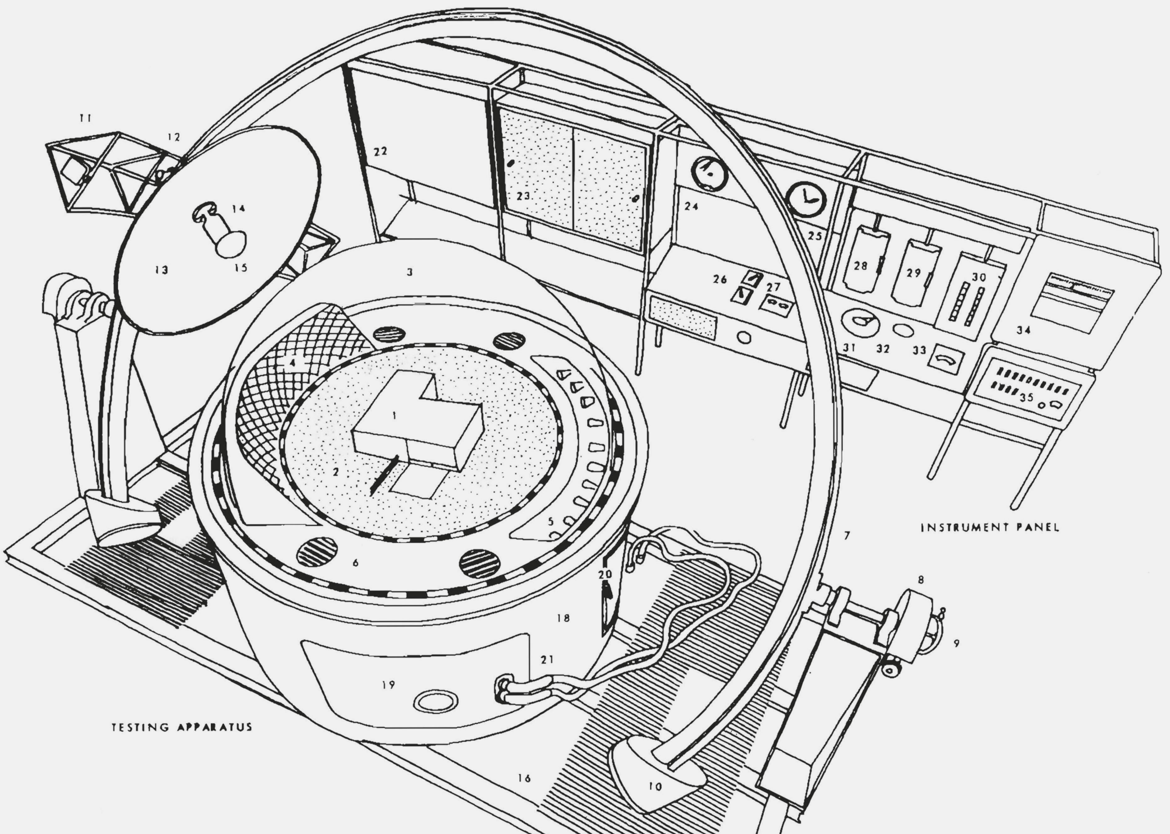
11 One of the first in the U.S. was built by the planner Henry Wright at Columbia University's Graduate School of Architecture. See A. F. Dufton and H. E. Beckett, "Orientation of Buildings: Sun Planning by Means of Models," *Journal of the Royal Institute of British Architects*, 38 (1931), p. 50; and G. Manley, "Microclimatology—Local Variations of Climate Likely to affect the Design and Siting of Buildings," *Journal of the Royal Institute of British Architects*, 56 (1949), pp. 317–23.

12 "The 'Form and Climate' Research Group," *Interiors*, 112, no. 12 (1953), pp. 52–3.

13 George Atkinson, "Building in the Tropics: Research into Housing in Tropical Countries, especially in the Commonwealth," *Journal of the Royal Institute of British Architects*, 57 (1950), pp. 313–9.

f.4 Victor and Aladar Olgyays' thermoheliodon in the Princeton Architectural Laboratory, with explanatory drawing, c. 1957. → 160/161





EXPLANATORY DRAWING OF THE THERMOHELIODON

DESCRIPTION OF THE THERMOHELIODON

The laboratory machine consists of two major elements: the testing apparatus and the instrument panel. The description of its parts (see illustration on page 9) is as follows:

1. Experimental model constructed with architectural scaling 1' = 3/4", and thermal scaling of 1/6th of prototype.

   For exterior temperature measurements thermocouples, for interior heat observations thermistors are attached to it.
2. Experimental area of 4' in diameter consists of a sunken pan filled with soil native to locale being tested to insure proper thermal relations with ground. The pan rotates to give any desired wind orientation.
3. Plexiglas dome to cover experimental area and allow recirculation of the air for heating and cooling purposes.
4. Air inlet constructed from strips of corrugated plexiglas for least interference with radiation effects. The inlet is designed to direct air over the experimental area. Steel mesh screening in the throat of the inlet insures balanced airspeeds.
5. Air outlet, receiving air for recirculation. Ten heating coils operated in groups of two simulate temperature fluctuations during the test "day."

6. Grills over four 300 watt incandescent lamps which by reflection from the dome's inner surface simulate diffuse sky radiation. The surface of the outer ring of the experimental surface is covered by neutral gray linoleum.
7. Latitude ring forming track for sun's path, variable according to latitude.
8. Protractor for positioning latitude.
9. Crank for tilting latitude ring.
10. Counterweight.
11. Month bridge allowing compensation in sun's path for seasonal variations. Adjustments are calibrated in 10-day intervals.
12. 1/75 HP electric motor geared to drive sun around the latitude ring. Path of 180° run (12 hours scaled to 1/36) takes 20 minutes.
13. Polished aluminum parabolic reflector of 4' in diameter to produce parallel rays from radiation source.
14. Incandescent 5000 watt bulb for simulating sun's radiation.
15. Small hemispherical aluminum reflector to intercept non parallel direct radiation and redirect energies to parabolic reflector. Not shown in the drawing is the equalizing grill before the large reflector.

16. Understructure of the testing apparatus built of steel I sections.
17. Iron cat-walk.
18. Cylindrical base of experimental area. The whole structure rotates on cast iron rollers to allow for any desired sun orientation.
19. Grill to allow access to one HP motor with variable pulleys to achieve wind velocities from 50 to 1000 ft./minute. Most tests are run at 440 rpm (5mph). A 24" fan circulates the air through a wire lath and asbestos plaster throat toward the inlet.
20. Exhaust door for expelling warm air and bleeding in room temperature air for cooling purposes.
21. From the cold junction and terminal strips (not shown in drawing as it is on the other side of the base) the temperature measuring wires enter into a flexible plastic tube which allows rotation of the base. The wiring from here is connected to the instrument panel through a conduit under the floor.
22. Chalk board.
23. Compartment for instruments.
24. Ambient temperature and relative humidity recorder.
25. Clock geared to run at scaled time (one hour equals 100 seconds).

26. Two 8-point switches for thermocouples.
27. Potentiometer to measure the emf developed by the thermocouples.
28. Main switch for the artificial sun's 50 amp current supply.
29. Main switch for low current supply.
30. Control switches for heaters, indirect radiation, fan, sun-motor drive, and for instrumentation.
31. Powerstat for varying voltage and consequent intensities of sun radiation.
32. Variac for varying intensities of diffuse radiation.
33. Galvanometer to register air temperatures under the dome.
34. Automatic recording instrument adjusted to read at 2-second intervals thermistor relayed fluctuations of temperature produced inside the model house.
35. Balancing panel for thermistors.

Page 13 illustrates the plan, views, and section of the Thermoheliodon in geometrical projection.

accounting of the site's climate. The Olgyays had been brought to Princeton in 1953 to work on an analysis of shading systems for the aluminum manufacturer ALCOA, as part of a broader research project on metal curtain walls. The Princeton Architectural Laboratory, built in 1948 by Jean Labatut, was the site of these experiments—the Olgyay twins, hampered by their poor spoken English and by perpetually temporary, grant-based contracts (they were officially "Research Associates in Architecture," with very limited teaching duties) focused their activities at the Lab.

The components of the thermoheliodon precisely express how climate was defined in the period: the arc of the sun was carefully calibrated; there was also an adjustable screen for refining wind direction, and a shallow pit in the middle, where soil from the building site was to be placed; humidity was controlled by moisture input from jets on the right; and all of this was sealed in a dome that could approximate some larger-scale atmospheric patterns. Compared to the heliodons just described, significantly more detailed models of the climatic world became available here to the designer.

Referred to as a "Laboratory Machine for Testing Thermal Behavior of Buildings," it was developed so the Olgyays could better conceptualize and calibrate what they came to call the "comfort zone"—the thermal state, as they defined it, "wherein the average person will not experience the feeling of discomfort." [14] The zone was modeled on a number of bioclimatic charts—similar to many of the physiometric charts of the early twentieth century, but distinct in the clarity of the specific condition ideal for human habitation. f.5 In this image, the y-axis is temperature; the x-axis is humidity. The upper dotted line, angled as it responds to both temperature and humidity, indicates a limit beyond which there is danger of sunstroke; the lower dotted line simply indicates freezing. The centerline is speculative, suggesting how a shading system cuts through these extremes and neutralizes them—and it sits, as one can see, at the bottom of the comfort zone.

These are just some of the images that the thermoheliodon helped to produce. Based on climate analyses, data from a given area could be placed on this graph, and analyzed. These data points would be translated into drawn shapes for each month, and arranged across the graph to show their relative co-extension with the comfort zone in a non-manipulated state. Other drawings interpreted this chart as a "timetable of climatic needs," with the dark areas in the center showing the over-heated periods that require a focused shading approach. Based on such an analysis, a basic building shape could be developed, with

14 Victor Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism* (Princeton, NJ: Princeton University, 1963), p. 18.

material and shading differences across each façade so as to best engage with the specifics of the building's climatic surround. A building model was then constructed and placed in the center of the thermoheliodon device and subjected to a number of tests, based on what was a relatively remarkable amount of data about a given building site.

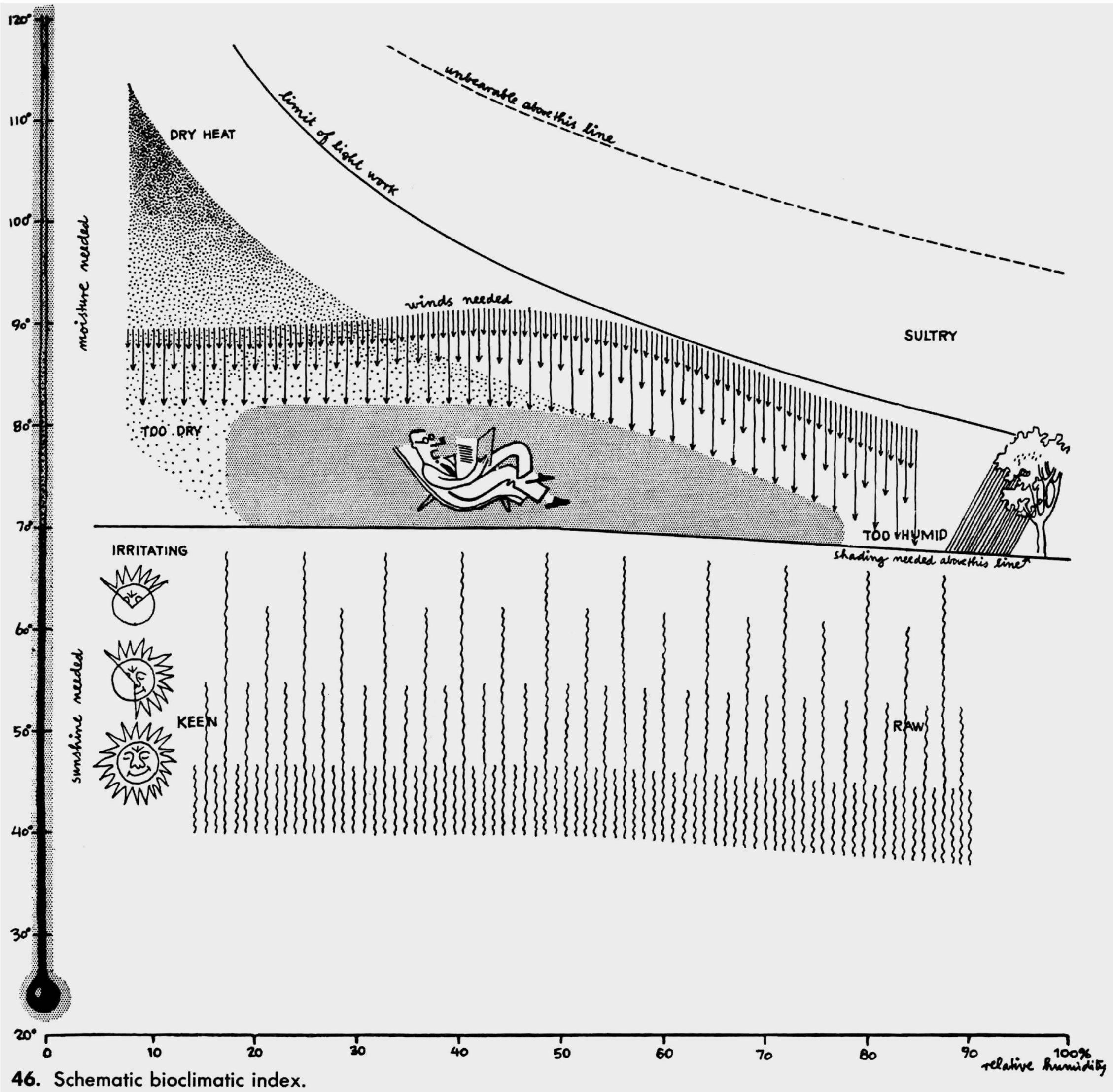
At the same time it is worth noting that the thermoheliodon, on its stated functional terms, did not really work. The problem had to do with the thermal capacity of materials: the model buildings that were inserted into the device were tested for shape and orientation, but the interior climatic conditions—the comfort zone itself—could not be adequately monitored because of the difficulty of scaling up the thermal properties of materials. A small brick operates very differently, on thermal terms, than does a large brick. Indeed, a significant portion of the report they submitted to the National Science Foundation (NSF) focused on "Scaling Criteria for Heat Transfer in Model Experiments." [15] Their attempts to take into account materials, humidity, and heat exchange read almost as an extended lament expressed in calculus—a longing for a more direct means to predict a building's performance. When seeking additional funding, they proposed to build identical test houses in Princeton, Montreal, and Los Angeles, and to maintain constant data analysis of these three sites, triangulating and adjusting their calculative matrix according to the recent historical record. Their funding was not renewed.

15 Victor Olgyay, *Report on the Thermoheliodon: Laboratory Machine for the Testing of Thermal Behavior through Model Structures* (Princeton, NJ: Princeton School of Architecture, 1957), pp. 39ff.

The thermoheliodon was at the center of a diverse body of images, machines, and buildings that attempted to recast the role of architecture in examining and understanding the relationship between humans and nature in the period. The Olgyays designed a number of houses in the Princeton area, and also consulted with well-known mid-century architects to provide shading systems for their designs. Among many other projects, they worked with Josep Lluis Sert on Peabody Terrace in Cambridge, MA; with Bernard Zehrfuss, Pier Luigi Nervi, and Marcel Breuer on the UNESCO building in Paris; and with Walter Gropius and The Architects Collaborative (TAC) on plans for the University of Baghdad. Aladar also collaborated with the engineer Maria Telkes on developing a prototype of the "Solar Wall" for the Curtis Wright Corporation. [16]

16 Aladar Olgyay and Maria Telkes, "The Principle of the Solar Wall," *American Artisan* (August 1949). Information on the Olgyays' collaborations comes from the Victor Olgyay Collection, Special Collections and Archives, Design Library, Arizona State University.

With the thermoheliodon, as with the not-so-utopian house, the physical capacities of the machine are not its most performative components—the immaterial, more than the material effects, are of interest. The experiments undertaken with the device and the images that it produced allowed for new conceptions of the



46. Schematic bioclimatic index.

f.5 The "Schematic bioclimatic index" from Victor Olgyay, *Design with Climate*, 1963.

human. Indeed, the thermoheliodon was itself something of a test case for more precisely understanding how increased technical knowledge—about the climate system, about architectural methods to engage it—could inform new desires, and lead to new ways of living. Some of the images that it produced constitute a new type of diagram, one that operates as an expressive image of technological knowledge—an image that places "humans" explicitly at the center of a complex arrangement of "natural" and "architectural" elements, as a means to operate upon all three of these concepts simultaneously.

The Olgyays' "schematic bioclimatic index" clarifies the extent to which the thermoheliodon and its attendant diagrammatic practices was a biopolitical project, an attempt to enact a new mode of being, for better or worse—a mode we can see today as shot through with the anxiety of the not-so-utopian. **f.5** The image of the human in figure 5 is protected, sheltered in an ideal, abstracted space—it could well be Aladar Olgyay, as he was always photographed with a pipe—relaxing on a chaise longue, reading the newspaper and completely at ease; without irritation, and apparently beyond the reach of any of the potentially threatening climatic conditions surrounding him. Temporally and spatially, he is a stable, protected figure—solid in the experience of well-designed space; consistent across changes in the elements that the past, present, or future can bring. In 1957, so this quasi-technical image seems to suggest, the project of climatic simulation was to produce a condition of stasis—a stasis that was, importantly, rendered as such through the intervention of carefully considered, machine-tested architectural methods.

Though the thermoheliodon was designed and built long before the specter of climate change cast a shadow on the prospects for unlimited economic expansion, these images of and aspirations for a static human condition are implicated in and inserted into a set of relationships that have, since the mid-twentieth century, attempted to assess the possible consequences of human behavior as it relates to the state of the global ecosystem. The Olgyays' bioclimatic analyses and their engagement at conferences with physiologists, biometeorologists, and ecologists clarifies, again, how the thermohelidon's image effects helped

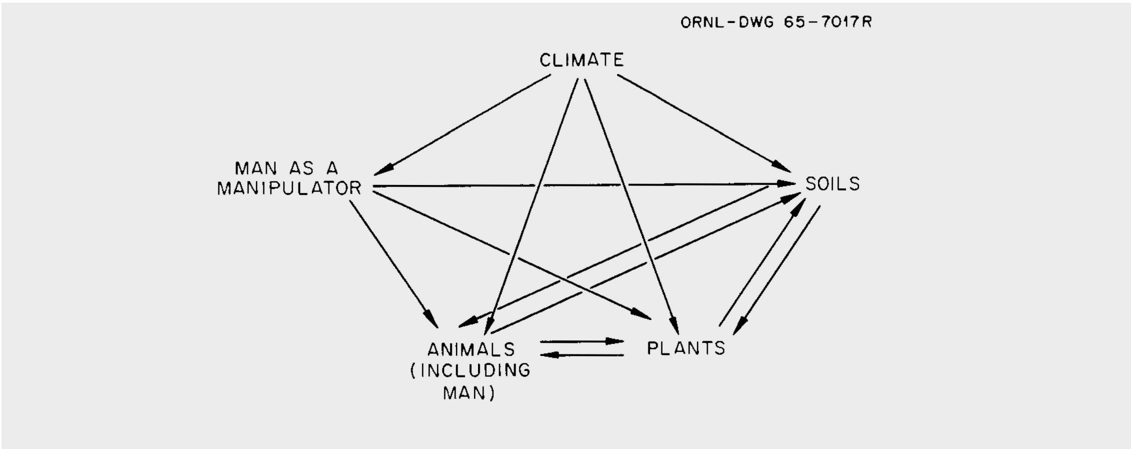


Fig. 1. An ecosystem is an integrated complex of living and nonliving components. Each component nfluenced by the others, with the possible exception of macroclimate. And now man is on the verge of rting meaningful influence over macroclimate.

f.6 George van Dyne, "An ecosystem is ..." from *Ecosystems, Systems Ecology, and Systems Ecologists*, 1966.

to restructure the distinction between humans and nature just as the epistemological significance of that distinction was beginning to dissolve. The concept of "the environment" as a site for human anxiety was taking root, and the notion of the ecosystem, being developed in the biological sciences, began to express this re-conception most clearly. **f.6** There was a growing recognition of the complexity of human agency—in the diagram in figure 6, drawn by George van Dyne as one of the early explanations of the ecosystem concept, "man" is positioned both as part of the animal world and "as manipulator;" i.e. as a force of nature itself, biological and eventually geological, that here begins to be conceived of as not subject to environmental conditions, but as having a primary role in transforming them. As Van Dyne noted in 1966: "now man is on the verge of exerting meaningful influence over macroclimate" while persisting, all the same, in "his" animal or biological state. [17]

17 George van Dyne, *Ecosystems, Systems Ecology, and Systems Ecologists* (Oak Ridge, TN: U.S. Atomic Energy Commission, 1966), p. 3.

This complex consideration of human and environmental agency, developed in different contexts at least since the mid-nineteenth century, has reached something of an apex in the contemporary framework of the Anthropocene—the seemingly new epoch, "the human era" in which we all have been living for some time, defined by a perspective that sees human activities as structuring geophysical and geological systems. [18] The positioning of humans and environments in systems models also begins to suggest a re-positioning of the species: rather than protected, stable, and static, the human is vulnerable, and subject to risk—and also to hubris, mishap, and misconception. Entangled, rather than in control. Media machines in the 1950s produced images that help to frame species-existential threats of climate change on a broader historical horizon. At stake, in the end, is the normative approach to the relationship between understanding and agency that persists. [19] What other conceptions can emerge, as we imagine a new role for architecture, and for speculative image-making, in encountering the threats and opportunities of the Anthropocene? A risk for architectural discourse is to approach these challenges as simply another opportunity for design engagement, rather than as an imperative for speculation, for imagining new forms of collectivity, with and through architectural-media machines. Such an imperative recasts the promise of the field's contribution to resolving environmental problems: not merely to render buildings more energy-efficient but also to restructure forms of human engagement.

18 See, for example, George Perkins Marsh, *Man and Nature; or, Physical Geography as Modified by Human Action* (Seattle: University of Washington Press, 2003 [1865]). On the Anthropocene, see Eileen Crist, "On the Poverty of Our Nomenclature," *Environmental Humanities*, 3 (2013), pp. 129–47.

19 Wendy Hui Kyong Chun, "On Hypo-Real Models or Global Climate Change: A Challenge for the Humanities," *Critical Inquiry*, 41, no. 3 (2015), pp. 675–703; here p. 677. See also Ulrich Beck, *Risk Society: Toward a New Modernity* (Thousand Oaks, CA: Sage, 1992).